Beverley Taylor Sorenson Center for the Arts

Southern Utah Museum of Art

Volume II of II

Southern Utah University

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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. This Section includes the following fire-suppression piping inside the building:

1. Wet-pipe sprinkler systems.
2. Dry-pipe sprinkler systems.
3. Preaction sprinkler systems.

B. Related Sections include the following:

1. Division 10 Section "Fire Extinguisher Cabinets" and "Fire Extinguishers" for cabinets and fire extinguishers.
2. Division 32 Section "Facility Water Distribution Piping" for piping outside the building.
3. Division 28 Section "Fire Detection and Alarm" for alarm devices not specified in this Section.

C. Piping shall be domestic.

D. Dry-pipe sprinkle system to server over-hangs and canopy areas.

E. Double-interlock pre-action system to serve the gallery areas and art collection areas. Rooms include S-100, S-101, S-102, S-105, and S-132.

1.3 DEFINITIONS

A. CPVC: Chlorinated polyvinyl chloride plastic.

B. CR: Chlorosulfonated polyethylene synthetic rubber.

C. High-Pressure Piping System: Fire-suppression piping system designed to operate at working pressure higher than standard 175 psig.

D. PE: Polyethylene plastic.

E. Underground Service-Entrance Piping: Underground service piping below the building.

1.4 SYSTEM DESCRIPTIONS

A. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts fusible link or destroys frangible device. Hose connections are included if indicated.

B. Dry-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing compressed air. Opening of sprinklers releases compressed air and permits water pressure to open dry-pipe valve. Water then flows into piping and discharges from opened sprinklers.

C. Preaction Double Interlock Sprinkler System: Automatic sprinklers are attached to piping containing air. Actuation of fire-detection system and automatic sprinklers in same area as sprinklers opens deluge valve, permitting water to flow into piping and to discharge from sprinklers that have opened.

1.5 PERFORMANCE REQUIREMENTS

A. Standard Piping System Component Working Pressure: Listed for at least 175 psig.

B. Fire-suppression standpipe system design shall be approved by authorities having jurisdiction.

C. Design sprinkler piping according to the following and obtain approval from engineer, prior to submitting to other authorities having jurisdiction:

1. Design sprinkler system with the following 10% reduced flow data:

Flow data available at 300 West and Center Street, Cedar City, Utah

Static – 67-psi

Residual – 63-psi @ 1061-gpm flowing

Date of Test – 5/5/2014 by VBFA, Inc.

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. Stage Areas: Ordinary Hazard, Group 2.
b. Theater In-the-round Areas: Ordinary Hazard, Group 2.
c. Electrical Equipment Rooms: Ordinary Hazard, Group 1.
d. General Storage Areas: Ordinary Hazard, Group 1.

e. Galleries: Ordinary Hazard, Group 1.
f. Exterior Canopy Areas: Ordinary Hazard, Group 2.
g. Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
h. Office and Public Areas: Light Hazard.
i. Restaurant Service Areas: Ordinary Hazard, Group 1.

4. Minimum Density for Automatic-Sprinkler Piping Design:

a. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. area.
b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. area.
c. Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm over 1500-sq. ft. area.
d. Extra-Hazard, Group 1 Occupancy: 0.30 gpm over 2500-sq. ft. area.
e. Extra-Hazard, Group 2 Occupancy: 0.40 gpm over 2500-sq. ft. area.
f. Special Occupancy Hazard: As determined by authorities having jurisdiction.

5. Maximum Protection Area per Sprinkler:

a. Office Spaces: 225 sq. ft..
b. Storage, Stage, Theater In-the-round, Galleries, Exhibition Areas: 130 sq. ft..
c. Mechanical Equipment Rooms: 130 sq. ft..
d. Electrical Equipment Rooms: 130 sq. ft..
e. Other Areas: According to NFPA 13 recommendations, unless otherwise indicated.

6. Total Combined Hose-Stream Demand Requirement: According to 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.
c. Extra-Hazard Occupancies: 500 gpm for 90 to 120 minutes.

D. Seismic Performance: Fire-suppression piping shall be capable of withstanding the effects of earthquake motions determined according to NFPA 13. Refer to Structural General Notes for seismic design coefficients and designations. Default values are not to be used.

1.6 SUBMITTALS

A. Product Data: For the following:
1. Piping materials, including dielectric fittings, flexible connections, and sprinkler specialty fittings.
2. Pipe hangers and supports, including seismic restraints.
3. Valves, including listed fire-protection valves, unlisted general-duty valves, and specialty valves and trim.
4. Air compressors, including electrical data.
5. Sprinklers, escutcheons, and guards. Include sprinkler flow characteristics, mounting, finish, and other pertinent data.
6. Fire department connections, including type; number, size, and arrangement of inlets; caps and chains; size and direction of outlet; escutcheon and marking; and finish.

7. Alarm devices, including electrical data.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Fire-hydrant flow test report.

D. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations, if applicable. Drawings are to be approved by Engineer prior to submission to State Fire Marshal.

E. Field Test Reports and Certificates: 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" and "Contractor's Material and Test Certificate for Underground Piping."

F. Welding certificates.

G. Field quality-control test reports.

H. Operation and Maintenance Data: For standpipe and sprinkler specialties to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Installer Qualifications:

1. An experienced installer who has designed and installed fire-suppression piping similar to that indicated for this Project and obtained design approval and inspection approval from authorities having jurisdiction. The Engineer requires evidence to support the ability of the contractor to perform work in the scope and volume as specified. A contractor, who cannot show such experience, may be found not suitable to perform the work. The following are the approved contractors for this project:

a. PRE-APPROVED CONTRACTORS LIST
   1) Alta Fire
   2) Certified Fire
   3) Chaparral Fire
   4) Delta Fire
   5) Quality Fire Protection
   6) Fire Engineering
   7) Fire Services Inc.
   8) Simplex-Grinnell
   9) Western Automatic
   10) Or Prior Approved Equal

b. A contractor not listed in the “PRE-APPROVED CONTRACTORS LIST” must receive prior approval from the engineer to bid this project.

B. 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.

1. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer or NICET Level III technician.

C. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

D. NFPA Standards: Fire-suppression-system equipment, specialties, accessories, installation, and testing shall comply with the following:

1. NFPA 13, "Installation of Sprinkler Systems."
2. NFPA 14, "Installation of Standpipe, Private Hydrant, and Hose Systems."
3. NFPA 24, "Installation of Private Fire Service Mains and Their Appurtenances."

E. International Conference of Building Code Officials codes and standards complying with the following:

1. IBC-2012, “International Building Code.”
2. IFC-2012, “International Fire Code.”

1.8 COORDINATION

A. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

1.9 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. Sprinkler Cabinets: Finished, wall-mounting, steel cabinet with hinged cover, 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 on Project.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified. All products to be UL Listed or FM Global approved.

2.2 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell end and plain end.

1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, Class 53, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
2. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron gland, rubber gasket, and steel bolts and nuts.

B. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell end and plain end.

1. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
2. Gaskets: AWWA C111, rubber.

2.3 STEEL PIPE AND FITTINGS

A. Threaded-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795, hot-dip galvanized where indicated and with factory- or field-formed threaded ends.

1. Cast-Iron Threaded Flanges: ASME B16.1.
2. Malleable-Iron Threaded Fittings: ASME B16.3.
3. Gray-Iron Threaded Fittings: ASME B16.4.
4. Steel Threaded Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, seamless steel pipe hot-dip galvanized where indicated. Include ends matching joining method.
5. Steel Threaded Couplings: ASTM A 865 hot-dip galvanized-steel pipe where indicated.

B. Plain-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795 hot-dip galvanized-steel pipe where indicated.

1. Locking-Lug Fittings: UL 213, ductile-iron body with retainer lugs that require one-quarter turn to secure pipe in fitting not allowed.

C. Plain-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795 hot-dip galvanized-steel pipe where indicated.

1. Steel Welding Fittings: ASTM A 234/A 234M, and ASME B16.9 or ASME B16.11.
2. Steel Flanges and Flanged Fittings: ASME B16.5.

D. Grooved-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795, hot-dip galvanized where indicated and with factory- or field-formed, roll-grooved ends.

1. Grooved-Joint Piping Systems:

a. Manufacturers:

1) Anvil International, Inc.
2) Central Sprinkler Corp.
3) Victaulic Co. of America.
4) Ward Manufacturing.

b. Grooved-End Fittings: UL-listed, ASTM A 536, ductile-iron casting with OD matching steel-pipe OD.
c. Grooved-End-Pipe Couplings: UL 213 and AWWA C606, rigid pattern, unless otherwise indicated; gasketed fitting matching steel-pipe OD. Include ductile-iron housing with keys matching steel-pipe and fitting grooves, prelubricated rubber gasket listed for use with housing, and steel bolts and nuts.

E. Threaded-End, Threadable, Thinwall Steel Pipe: ASTM A 135 or ASTM A 795, with wall thickness less than Schedule 40 and greater than Schedule 10, and with factory- or field-formed threaded ends.

1. Cast-Iron Threaded Flanges: ASME B16.1.
2. Malleable-Iron Threaded Fittings: ASME B16.3.
3. Gray-Iron Threaded Fittings: ASME B16.4.
4. Steel Threaded Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, seamless steel pipe.
5. Steel Threaded Couplings: ASTM A 865.

F. Plain-End, Threadable, Thinwall Steel Pipe: ASTM A 135 or ASTM A 795, with wall thickness less than Schedule 40 and greater than Schedule 10.

1. Locking-Lug Fittings: UL 213, ductile-iron body with retainer lugs that require one-quarter turn to secure pipe in fitting not allowed.

G. Plain-End, Threadable, Thinwall Steel Pipe: ASTM A 135 or ASTM A 795, with wall thickness less than Schedule 40 and greater than Schedule 10.

1. Steel Welding Fittings: ASTM A 234/A 234M, and ASME B16.9 or ASME B16.11.
2. Steel Flanges and Flanged Fittings: ASME B16.5.

H. Grooved-End, Threadable, Thinwall Steel Pipe: ASTM A 135 or ASTM A 795, with wall thickness less than Schedule 40 and greater than Schedule 10, and with factory- or field-formed, roll-grooved ends.

1. Grooved-Joint Piping Systems:

a. Manufacturers:

1) Anvil International, Inc.
2) Central Sprinkler Corp.
3) Victaulic Co. of America.
4) Ward Manufacturing.

b. Grooved-End Fittings: UL-listed, ASTM A 536, ductile-iron casting with OD matching steel-pipe OD.
c. Grooved-End-Pipe Couplings: UL 213 and AWWA C606, rigid pattern, unless otherwise indicated; gasketed fitting matching steel-pipe OD. Include ductile-iron housing with keys matching steel-pipe and fitting grooves, prelubricated rubber gasket listed for use with housing, and steel bolts and nuts.

I. Grooved-End, Schedule 10 Steel Pipe: ASTM A 135 or ASTM A 795, with factory-, or field- roll grooved ends. Plain ends are not allowed.

J. Plain-End, Nonstandard OD, Thinwall Steel Pipe: ASTM A 135 or ASTM A 795, with wall thickness less than Schedule 10 is not allowed.

K. Plain-End, Hybrid Steel Pipe: ASTM A 135 or ASTM A 795, lightwall, with wall thickness less than Schedule 10 and greater than Schedule 5 is not allowed.

L. Grooved-End, Hybrid Steel Pipe: ASTM A 135 or ASTM A 795, lightwall, with wall thickness less than Schedule 10 and greater than Schedule 5; with factory- or field-formed, roll-grooved ends are not allowed.

M. Schedule 5 Steel Pipe: ASTM A 135 or ASTM A 795, lightwall, with plain ends is not allowed.

2.4 COPPER TUBE AND FITTINGS

A. Soft Copper Tube: ASTM B 88, Type L, water tube, annealed temper; with plain ends.

1. Copper fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint pressure type. Furnish only wrought-copper fittings if indicated.
2. Brazing Filler Metals: AWS A5.8, BCuP-3 or BCuP-4.

B. Plain-End, Hard Copper Tube: ASTM B 88, Type K or ASTM B 88, Type L, water tube, drawn temper.

1. Copper Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint pressure type. Furnish only wrought-copper fittings if indicated.
2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint end. Furnish Class 300 flanges if required to match tubing system.
3. 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.
4. Copper, Mechanically Formed Tee Option: For forming T-branch on copper water tube not allowed.
5. Brazing Filler Metals: AWS A5.8, BCuP-3 or BCuP-4.

C. Grooved-End, Hard Copper Tube: ASTM B 88, Type K or ASTM B 88, Type L, water tube, drawn temper; with factory- or field-formed, roll-grooved ends.

1. Copper, Mechanically Formed Tee Option: For forming T-branch on copper water tube not allowed.
2. Grooved-Joint Systems:

a. Manufacturers:

1) Anvil International, Inc.
2) Victaulic Co. of America.

b. Grooved-End Copper Fittings: ASTM B 75, copper tube or ASTM B 584, bronze casting. Fittings may have ends factory or field expanded to steel-pipe OD if required for copper tube systems using grooved-end-pipe couplings.
c. Grooved-End-Tube Couplings: UL 213, rigid pattern, unless otherwise indicated; gasketed fitting equivalent to AWWA C606, but made to match copper-tube OD. Include ductile-iron housing with keys matching steel-pipe and fitting grooves, prelubricated rubber gasket listed for use with housing, and steel bolts and nuts. Use grooved-end-pipe couplings for tube and fitting that have expanded ends.

2.5 FLEXIBLE CONNECTORS

A. Flexible connectors shall have materials suitable for system fluid. Include 175-psig minimum working-pressure rating and ends according to the following:

1. NPS 2 and Smaller: Threaded.
2. NPS 2-1/2 and Larger: Flanged.
3. Option for NPS 2-1/2 and Larger: Grooved for use with grooved-end-pipe couplings.

B. Manufacturers:

1. Easy Flex Co.

2. Flex-Hose Co., Inc.
3. Flexicraft Industries.
4. Flex-Pression, Ltd.
5. Flex-Weld, Inc.
6. Hyspan Precision Products, Inc.
7. Metraflex, Inc.

C. Bronze-Hose, Flexible Connectors: Corrugated, bronze, inner tubing covered with bronze wire braid. Include copper-tube ends or bronze flanged ends, braze welded to hose.

D. Stainless-Steel-Hose/Steel Pipe, Flexible Connectors: Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include steel nipples or flanges, welded to hose.

E. Stainless-Steel-Hose/Stainless-Steel Pipe, Flexible Connectors: Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include stainless-steel nipples or flanges, welded to hose.

2.6 CORROSION-PROTECTIVE ENCASEMENT FOR PIPING

A. Encasement for Underground Metal Piping: ASTM A 674 or AWWA C105, PE film, 0.008-inch minimum thickness, tube or sheet.

2.7 SPRINKLER SPECIALTY FITTINGS

A. Sprinkler specialty fittings shall be FMG approved, with 175-psig minimum working-pressure rating, and made of materials compatible with piping. Sprinkler specialty fittings shall have 250-psig minimum working-pressure rating if fittings are components of high-pressure piping system.

B. Sprinkler Drain and Alarm Test Fittings: Cast- or ductile-iron body; with threaded or locking-lug inlet and outlet, test valve, and orifice and sight glass.

1. Manufacturers:

a. Central Sprinkler Corp.
b. Fire-End and Croker Corp.
c. Viking Corp.
d. Victaulic Co. of America.

C. Sprinkler Branch-Line Test Fittings: Brass body with threaded inlet, capped drain outlet, and threaded outlet for sprinkler.

1. Manufacturers:

a. Elkhart Brass Mfg. Co., Inc.

b. Fire-End and Croker Corp.
c. Potter-Roemer; Fire-Protection Div.

D. Sprinkler Inspector's Test Fitting: Cast- or ductile-iron housing with threaded inlet and drain outlet and sight glass.

1. Manufacturers:

a. AGF Manufacturing Co.
b. Central Sprinkler Corp.
c. G/J Innovations, Inc.
d. Triple R Specialty of Ajax, Inc.

E. Drop-Nipple Fittings: UL 1474, adjustable with threaded inlet and outlet, and seals.

1. Manufacturers:

a. CECA, LLC.
b. Merit.

F. Dry-Pipe-System Fittings: UL listed for dry-pipe service.

2.8 LISTED FIRE-PROTECTION VALVES

A. Valves shall be FMG approved, with 175-psig minimum pressure rating. Valves shall have 250-psig minimum pressure rating if valves are components of high-pressure piping system.

B. Gate Valves with Wall Indicator Posts:

1. Gate Valves: UL 262, cast-iron body, bronze mounted, with solid disc, nonrising stem, operating nut, and flanged ends.
2. Indicator Posts: UL 789, horizontal-wall type, cast-iron body, with hand wheel, extension rod, locking device, and cast-iron barrel.
3. Manufacturers:

a. Grinnell Fire Protection.
b. McWane, Inc.; Kennedy Valve Div.
c. NIBCO.
d. Stockham.

C. Ball Valves: Comply with UL 1091, except with ball instead of disc.

1. NPS 1-1/2 and Smaller: Bronze body with threaded ends.
2. NPS 2 and NPS 2-1/2: Bronze body with threaded ends or ductile-iron body with grooved ends.
3. NPS 3: Ductile-iron body with grooved ends.
4. Manufacturers:

a. NIBCO.
b. Victaulic Co. of America.

D. Butterfly Valves: UL 1091.

1. NPS 2 and Smaller: Bronze body with threaded ends.

a. Manufacturers:

1) Global Safety Products, Inc.
2) Milwaukee Valve Company.

2. NPS 2-1/2 and Larger: Bronze, cast-iron, or ductile-iron body; wafer type or with flanged or grooved ends.

a. Manufacturers:

1) Central Sprinkler Corp.
2) McWane, Inc.; Kennedy Valve Div.
3) Mueller Company.
4) NIBCO.
5) Victaulic Co. of America.

E. Check Valves NPS 2 and Larger: UL 312, swing type, cast-iron body with flanged or grooved ends.

1. Manufacturers:

a. American Cast Iron Pipe Co.; Waterous Co.
b. Central Sprinkler Corp.
c. Clow Valve Co.
d. Crane Co.; Crane Valve Group; Crane Valves.
e. Crane Co.; Crane Valve Group; Jenkins Valves.
f. Globe Fire Sprinkler Corporation.
g. Grinnell Fire Protection.
h. Hammond Valve.
i. McWane, Inc.; Kennedy Valve Div.
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q. Victaulic Co. of America.
r. Watts Industries, Inc.; Water Products Div.

F. Gate Valves: UL 262, OS&Y type.

1. NPS 2 and Smaller: Bronze body with threaded ends.

   a. Manufacturers:

      1) Crane Co.; Crane Valve Group; Crane Valves.
      2) Hammond Valve.
      3) NIBCO.
      4) United Brass Works, Inc.

2. NPS 2-1/2 and Larger: Cast-iron body with flanged ends.

   a. Manufacturers:

      1) Clow Valve Co.
      2) Crane Co.; Crane Valve Group; Crane Valves.
      3) Crane Co.; Crane Valve Group; Jenkins Valves.
      4) Hammond Valve.
      5) Milwaukee Valve Company.
      6) Mueller Company.
      7) NIBCO.
      8) United Brass Works, Inc.

G. Indicating Valves: UL 1091, with integral indicating device and ends matching connecting piping.

1. Indicator: Electrical, 115-V ac, prewired, single-circuit, supervisory switch and Visual.
2. NPS 2 and Smaller: Ball or butterfly valve with bronze body and threaded ends.

   a. Manufacturers:

      1) Milwaukee Valve Company.
      2) NIBCO.
      3) Victaulic Co. of America.

3. NPS 2-1/2 and Larger: Butterfly valve with cast- or ductile-iron body; wafer type or with flanged or grooved ends.

   a. Manufacturers:

      1) Central Sprinkler Corp.
      2) Grinnell Fire Protection.
      3) McWane, Inc.; Kennedy Valve Div.
      4) Milwaukee Valve Company.
      5) NIBCO.
      6) Victaulic Co. of America.

2.9 UNLISTED GENERAL-DUTY VALVES

A. Ball Valves NPS 2 and Smaller: MSS SP-110, 2-piece copper-alloy body with chrome-plated brass ball, 600-psig minimum CWP rating, blowout-proof stem, and threaded ends.

B. Check Valves NPS 2 and Smaller: MSS SP-80, Type 4, Class 125 minimum, swing type with bronze body, nonmetallic disc, and threaded ends.

C. Gate Valves NPS 2 and Smaller: MSS SP-80, Type 2, Class 125 minimum, with bronze body, solid wedge, and threaded ends.

D. Globe Valves NPS 2 and Smaller: MSS SP-80, Type 2, Class 125 minimum, with bronze body, nonmetallic disc, and threaded ends.

2.10 SPECIALTY VALVES

A. Sprinkler System Control Valves: FMG approved, cast- or ductile-iron body with flanged or grooved ends, and 175-psig minimum pressure rating. Control valves shall have 250-psig minimum pressure rating if valves are components of high-pressure piping system.

1. Manufacturers:

a. Central Sprinkler Corp.
b. Globe Fire Sprinkler Corporation.
c. Grinnell Fire Protection.
d. Reliable Automatic Sprinkler Co., Inc.
e. Star Sprinkler Inc.
f. Victaulic Co. of America.
g. Viking Corp.

2. Dry-Pipe Valves: UL 260, differential type; with bronze seat with O-ring seals, single-hinge pin, and latch design. Include UL 1486, quick-opening devices, trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.

a. Air-Pressure Maintenance Device: UL 260, automatic device to maintain correct air pressure in piping. Include shutoff valves to permit servicing without shutting down sprinkler piping, bypass valve for quick filling, pressure regulator or switch to maintain pressure, strainer, pressure ratings with 14- to 60-psig adjustable range, and 175-psig maximum inlet pressure.

1) Manufacturers:

a) AFAC Inc.
b) Central Sprinkler Corp.
c) General Air Products, Inc.
d) Globe Fire Sprinkler Corporation.

e) Grinnell Fire Protection.
f) Reliable Automatic Sprinkler Co., Inc.
g) Star Sprinkler Inc.
h) Viking Corp.

b. Air Compressor: UL 753, fractional horsepower, 120-V ac, 60 Hz, single phase.

B. Automatic Drain Valves: UL 1726, NPS 3/4, ball-check device with threaded ends.

1. Manufacturers:

a. Grinnell Fire Protection.

2.11 MANUAL CONTROL STATIONS (Pre-action)

A. Manual Control Stations: FMG approved, hydraulic operation, with union, NPS 1/2 pipe nipple, and bronze ball valve. Include metal enclosure labeled "MANUAL CONTROL STATION" with operating instructions and cover held closed by breakable strut to prevent accidental opening.

2.12 CONTROL PANELS (Pre-action)

A. Description: Single-area, two-area, or single-area cross-zoned type control panel as indicated, including NEMA ICS 6, Type 1 enclosure, detector, alarm, and solenoid-valve circuitry for operation of deluge valves. Panels contain power supply; battery charger; standby batteries; field-wiring terminal strip; electrically supervised solenoid valves and polarized fire alarm bell; lamp test facility; single-pole, double-throw auxiliary alarm contacts; and rectifier.

1. Panels: FMG approved when used with thermal detectors and Class A detector circuit wiring. Electrical characteristics are 120-V ac, 60 Hz, with 24-V dc rechargeable batteries.
2. Manual Control Stations: Electric operation, metal enclosure, labeled "MANUAL CONTROL STATION" with operating instructions and a cover held closed by breakable strut.

2.13 SPRINKLERS

A. Sprinklers shall be UL listed or FMG approved, with 175-psig minimum pressure rating. Sprinklers shall have 250-psig minimum 300-psig pressure rating if sprinklers are components of high-pressure piping system.

B. Manufacturers:

1. Central Sprinkler Corp.

2. Globe Fire Sprinkler Corporation.
3. Grinnell Fire Protection.
4. Reliable Automatic Sprinkler Co., Inc.
5. Star Sprinkler Inc.
6. Victaulic Co. of America.
7. Viking Corp.
8. Tyco Fire

C. Automatic Sprinklers: With heat-responsive element complying with the following:

1. UL 199, for nonresidential applications.

D. Sprinkler Types and Categories: Nominal 1/2-inch orifice for "Ordinary" temperature classification rating, unless otherwise indicated or required by application.

E. Sprinkler types, features, and options as follows:

1. Concealed ceiling sprinklers, including cover plate.
2. Extended-coverage sprinklers, not allowed unless approved in writing prior to bidding.
3. Flush ceiling sprinklers, including escutcheon, not allowed.
4. Pendent sprinklers.
5. Pendent, dry-type sprinklers.
6. Quick-response sprinklers.
7. Recessed sprinklers, including escutcheon.
8. Sidewall sprinklers.
9. Sidewall, dry-type sprinklers.
10. Upright sprinklers.

F. Sprinkler Finishes: Chrome plated, bronze, and painted. Finishes as approved by FM Global.

G. Special Coatings: Wax, lead, and corrosion-resistant paint.

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: Plastic, white finish, one piece, flat.
2. Sidewall Mounting: Plastic, white finish, one piece, flat.

I. Sprinkler Guards: Wire-cage type, including fastening device for attaching to sprinkler.

2.14 FIRE DEPARTMENT CONNECTIONS

A. Manufacturers:

1. Central Sprinkler Corp.
2. Elkhart Brass Mfg. Co., Inc.

3. Fire-End and Croker Corp.
4. Fire Protection Products, Inc.
5. Guardian Fire Equipment Incorporated.
6. Potter-Roemer; Fire-Protection Div.
7. Reliable Automatic Sprinkler Co., Inc.
8. United Brass Works, Inc.

B. Wall-Type, Fire Department Connection: UL 405, 175-psig minimum pressure rating; with corrosion-resistant-metal body with brass inlets, brass wall escutcheon plate, brass lugged caps with gaskets and brass chains, and brass lugged swivel connections. Include inlets with threads according to NFPA 1963 and matching local fire department sizes and threads, outlet with pipe threads, extension pipe nipples, check devices or clappers for inlets, and escutcheon plate with marking similar to "AUTO SPKR."

1. Type: Flush, with two inlets and square or rectangular escutcheon plate.
2. Finish: Polished brass.

2.15 ALARM DEVICES

A. Alarm-device types shall match piping and equipment connections.

B. Electrically Operated Alarm: UL 464, with 8-inch- minimum- diameter, vibrating-type, metal alarm bell with red-enamel factory finish and suitable for outdoor use.

1. Manufacturers:

a. Potter Electric Signal Company.
b. System Sensor.

C. Water-Flow Indicator: UL 346, electrical-supervision, paddle-operated-type, water-flow detector with 250-psig pressure rating and designed for horizontal or vertical installation. Include 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.

1. Manufacturers:

a. ADT Security Services, Inc.
b. Grinnell Fire Protection.
c. ITT McDonnell & Miller.
d. Potter Electric Signal Company.
e. System Sensor.
f. Viking Corp.
g. Watts Industries, Inc.; Water Products Div.

D. Pressure Switch: UL 753, electrical-supervision-type, water-flow switch with retard feature. Include single-pole, double-throw, normally closed contacts and design that operates on rising pressure and signals water flow.

1. Manufacturers:

a. Grinnell Fire Protection.
b. Potter Electric Signal Company.
c. System Sensor.
d. Viking Corp.

E. Valve Supervisory Switch: UL 753, electrical, single-pole, double-throw switch with normally closed contacts. Include design that signals controlled valve is in other than fully open position.

1. Manufacturers:

a. McWane, Inc.; Kennedy Valve Div.
b. Potter Electric Signal Company.
c. System Sensor.

F. Indicator-Post Supervisory Switch: UL 753, electrical, single-pole, double-throw switch with normally closed contacts. Include design that signals controlled indicator-post valve is in other than fully open position.

1. Manufacturers:

a. Potter Electric Signal Company.
b. System Sensor.

2.16 PRESSURE GAGES

A. Manufacturers:

1. Brecco Corporation.
2. Dresser Equipment Group; Instrument Div.
3. Marsh Bellofram.
4. WIKA Instrument Corporation.

B. Description: UL 393, 3-1/2- to 4-1/2-inch- diameter, dial pressure gage with range of 0 to 250 psig minimum.

1. Water System Piping: Include caption "WATER" or "AIR/WATER" on dial face.
2. Air System Piping: Include retard feature and caption "AIR" or "AIR/WATER" on dial face.

2.17 DOUBLE CHECK VALVE ASSEMBLIES

A. Manufacturers

1. Ames
2. Febco
3. Wilkins
4. Watts

B. Description; Resilient seated, spring loaded with testable outlets provided, as required by Authority Having Jurisdiction.

PART 3 - EXECUTION

3.1 PREPARATION

A. Engineer’s Water Analysis. See Flow Analysis provided by Van Boerum & Frank Associates.

3.2 EARTHWORK

A. Refer to Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.3 EXAMINATION

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

B. Examine walls and partitions for suitable thicknesses, fire- and smoke-rated construction, framing for hose-station cabinets, and other conditions where hose connections and stations are to be installed.

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

3.4 PIPING APPLICATIONS

A. Shop weld pipe joints where welded piping is indicated.

B. Do not use welded joints for galvanized-steel pipe.

C. Flanges, flanged fittings, unions, nipples, and transition and special fittings with finish and pressure ratings same as or higher than system's pressure rating may be used in aboveground applications, unless otherwise indicated.

D. 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.

E. Underground Service-Entrance Piping: Ductile-iron, push-on or mechanical-joint pipe and fittings and restrained joints. Include corrosion-protective encasement.

F. Sprinkler Main Piping: Use the following:

1. NPS 2 1/2 to 8: Schedule 10 steel pipe with threaded ends, or grooved ends. No plain ends allowed.
2. Outlets shall be welded.

a. Victaulic Brand Mechanical tee fittings may be used in lieu of welded outlets.

G. Branch line piping: Use the following:

1. NPS 2 and Smaller: Threadable steel pipe with threaded ends; cast- or malleable-iron threaded fittings; and threaded joints.

a. Victaulic Brand Mechanical tee fittings may be used

3.5 VALVE APPLICATIONS

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Fire-Protection-Service Valves: UL listed and FM approved for applications where required by NFPA 13 and NFPA 14.
2. General-Duty Valves: For applications where UL-listed and FM-approved valves are not required by NFPA 13 and NFPA 14.

a. Shutoff Duty: Use gate, ball, or butterfly valves.
b. Throttling Duty: Use globe, ball, or butterfly valves.

3.6 JOINT CONSTRUCTION

A. Refer to Division 23 Section "Common Work Result for HVAC" for basic piping joint construction.

B. Ductile-Iron-Piping, Grooved Joints: Use ductile-iron pipe with radius-cut-grooved ends; ductile-iron, grooved-end fittings; and ductile-iron, keyed couplings. Assemble joints with couplings, gaskets, lubricant, and bolts according to coupling manufacturer's written instructions.

C. Steel-Piping, Grooved Joints: Use Schedule 40 steel pipe with cut or roll-grooved ends and Schedule 30 or thinner steel pipe with roll-grooved ends; steel, grooved-end fittings; and steel, keyed couplings. Assemble joints with couplings, gaskets, lubricant, and bolts according to coupling manufacturer's written instructions. Use gaskets listed for dry-pipe service for dry piping.

3.7 WATER-SUPPLY CONNECTION

A. Install shutoff Backflow preventions assemblies, valve, pressure gage's, drain, and other accessories at connection to water service.

3.8 PIPING INSTALLATION

A. Refer to Division 23 Section "Common Work Result for HVAC" for basic piping installation.

B. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.

1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.

C. Install underground service-entrance piping according to NFPA 24 and with restrained joints.

D. Make connections between underground and above-ground piping using bolted flange.

E. Install mechanical sleeve seal at pipe penetrations in basement and foundation walls. Refer to Division 23 Section "Common Work Result for HVAC."

F. Use approved fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

G. Install unions adjacent to each valve in pipes NPS 2 and smaller. Unions are not required on flanged devices or in piping installations using grooved joints.

H. Install flanges or flange adapters on valves, apparatus, and equipment having NPS 2-1/2 and larger connections.

I. Install "Inspector's Test Connections" in sprinkler piping, complete with shutoff valve, sized and located according to NFPA 13.

J. Install sprinkler piping with drains for complete system drainage.

K. Install ball drip valves to drain piping between fire department connections and check valves. Drain to floor drain or outside building.

L. Install alarm devices in piping systems.

M. Hangers and Supports: Comply with NFPA 13 for hanger materials. Install according to NFPA 13 for sprinkler piping.

1. No powder driven studs allowed.
2. Wrap-around braces are to be provided at end of branch lines.

N. Earthquake Protection: Install piping according to NFPA 13 chapter 9 requirements, to protect from earthquake damage. Seismic Bracing shall be designed to withstand vertical forces and movement.

O. Install piping with grooved joints according to manufacturer's written instructions. Construct rigid piping joints, unless otherwise indicated, or required by NFPA 13 for flexibility in seismic zones.

P. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.

3.9 SPECIALTY SPRINKLER FITTING INSTALLATION

A. Install specialty sprinkler fittings according to manufacturer's written instructions.

3.10 VALVE INSTALLATION

A. Refer to Division 23 Section "Valves" for installing general-duty valves. Install fire-protection specialty valves, trim, fittings, controls, and specialties according to NFPA 13 and NFPA 14, manufacturer's written instructions, and authorities having jurisdiction.

B. Valves: Install fire-protection-service valves supervised-open, located to control sources of water supply except from fire department connections. Provide permanent identification signs indicating portion of system controlled by each valve.

C. Double Check Valve Assemblies: Install valves in vertical or horizontal position, per listings and for proper direction of flow.

D. Deluge Valves: Install in vertical position, in proper direction flow, in main supply to deluge system.

3.11 SPRINKLER APPLICATIONS

A. General: All sprinklers are to be quick response type. Sprinkler heads shall be of the latest design closed spray type for 155°F unless specified otherwise or required by code. Extended

coverage heads shall not be used. Orifices larger than 1/2" may be used as required by density and spacing demands. Use sprinklers according to the following applications:

1. Rooms without Ceilings: Upright and/or pendent sprinklers. Provide mechanical guards on all heads at or below 7'-0" height above the floor or where damage from room occupant use may occur.
2. Rooms with Ceilings: Semi-Recessed sprinklers.
3. Rooms with Ceilings: Concealed sprinklers, where indicated.
4. Wall Mounting: Sidewall sprinklers with recessed escutcheon.
5. Spaces Subject to Freezing and Exterior Canopies: Upright; pendent dry-type; and sidewall dry-type sprinklers. Use dry-type where area has ceiling.
6. Provide freeze proof type automatic sprinkler heads serving unconditioned spaces, areas subject to freezing and in other areas requiring their use.
7. Heads located within the air streams of unit heaters or other heat-emitting equipment shall be selected for proper temperature rating.
8. Sprinkler Finishes: Use sprinklers with the following finishes:

   a. Upright, Pendent, and Sidewall Sprinklers: Chrome in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view.
   b. Concealed Sprinklers: Rough brass, with White cover plate to match ceiling color.
   c. Recessed Sprinklers: White, with white escutcheon.

B. Sprinklers: Use the following:

1. All sprinklers shall be listed, quick response type.
2. Sprinklers in future finish spaces (shelled) 10' x 10' spacing, shall be upright installed with 1 x ½" bushing, to accommodate future finishes.
3. Finish ceiling spaces shall have recessed type escutcheon.

3.12 SPRINKLER INSTALLATION

A. Every effort shall be required to insure that the heads form a symmetrical pattern in the ceiling with the ceiling grid, lights, diffusers and grilles. Offsets shall be made in piping to accommodate ductwork in the ceiling. Heads should be symmetrical and all piping run parallel or perpendicular to building lines.

1. In no case shall sprinkler heads be installed closer than approved distances from ceiling obstructions and HVAC ductwork.
2. Sprinkler heads shall not conflict with tile grids.
3. Sprinkler heads shall be located near center of corridors.

B. Where layout of sprinkler heads is shown on reflected ceiling plans the locations shall be followed unless approval is obtained from the Architect or such locations shown do not meet the requirements of NFPA-13. In either case, approval of the Architect shall be obtained in writing before sprinkler head locations are changed. If the installation of additional heads is needed to conform to NFPA 13 requirements in areas where heads are shown on reflected ceiling plans, they shall be included in the contract price.

C. Install sprinklers in patterns indicated.

D. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing. Use dry-type sprinklers with water supply from heated space.

E. Future finish shelled and tenant finish; Shell spaces shall be piped to accommodate future. Install sprinklers with 1" x ½" bushings, and space heads at a maximum spacing of 100 sq. ft. per head. Occupancy shall be Ordinary-Hazard Group 1 Design.

F. Concealed type sprinkler shall be installed in the following areas:

1. Areas as indicated on drawings.

3.13 CONNECTIONS

A. Connect water-supply piping and standpipes and sprinklers where indicated.

B. Install ball drip valves at each check valve for fire department connection. Drain to floor drain or outside building.

C. Connect piping to specialty valves, hose valves, specialties, fire department connections, and accessories.

D. Electrical Connections: Power wiring is specified in Division 28.

E. Connect alarm devices to fire alarm.

3.14 LABELING AND IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13 and NFPA 14 and in Division 23 Section "Common Work Result for HVAC."

3.15 FIELD QUALITY CONTROL

A. Flush, test, and inspect sprinkler piping according to NFPA 13, "System Acceptance" Chapter.

B. Replace piping system components that do not pass test procedures and retest to demonstrate compliance. Repeat procedure until satisfactory results are obtained.

C. Report test results promptly and in writing to Architect and authorities having jurisdiction.

D. Whether the underground serving the sprinkler system is done by this contractor or another, this contractor will be responsible to assure and have in his possession a certificate that the

underground has been flushed and tested by the contractor who installed it in accordance with NFPA-24 prior to connection of the underground piping to the overhead sprinkler system.

3.16 CLEANING

A. Clean dirt and debris from sprinklers.

B. Remove and replace sprinklers having paint other than factory finish.

3.17 PROTECTION

A. Protect sprinklers from damage until Substantial Completion.

3.18 COMMISSIONING

A. Verify that specialty valves, trim, fittings, controls, and accessories are installed and operate correctly.

B. Verify that specified tests of piping are complete and that “Material Test Certificates” are complete.

C. Verify that damaged sprinklers and sprinklers with paint or coating not specified are replaced with new, correct type.

D. Verify that sprinklers are correct types, have correct finishes and temperature ratings, and have guards as required for each application.

E. Verify fire department connections have threads compatible with local fire department equipment.

F. Fill wet-pipe sprinkler piping with water.

G. Coordinate with fire alarm tests. Operate as required.

3.19 DEMONSTRATION & TESTS

A. Demonstrate equipment, specialties, and accessories. Review operating and maintenance information.

B. All tests will be conducted as required by the local authority having jurisdiction, and in no case less than those required by NFPA standards. As a minimum, piping in the sprinkler system shall be tested at a water pressure at 200 psi for a period of not less two hours, or at 50 psi in excess of the normal pressure when the normal pressure is above 150 psi. Bracing shall be in place, and air shall be removed from the system through the hydrants and drain valves

before the test pressure is applied. No apparent leaks will be permitted on interior or underground piping.

C. The local jurisdiction having authority and the Utah State Fire Marshal's office (where required) shall be notified at least three working days in advance of all tests and flushing. This includes any flushing of underground, hydrostatic testing, or flow testing that may be required.

D. This contractor shall make all the required tests to the sprinkler system as required by code. He shall be responsible to assure that the Contractor Test Certificates for the overhead, backflow and underground work are completed and delivered to the owner's insurance underwriter to assure proper insurance credit.

E. All tests requiring the witnessing by local authorities will be the responsibility of this contractor. If tests are not run or do not have the proper witness, then they will be run later and all damage caused by the system, or caused in uncovering the system for such test, will be borne by this contractor.

3.20 WARRANTY

A. This contractor shall warranty the sprinkler system and all its components for one year from the date of acceptance by the owner. Any costs incurred to extend any warranties of materials to assure this time frame shall be borne by this contractor.

B. Provide Operation and Maintenance Manuals with correct as-builts test certificates and warranties included. A minimum 6 sets to be provided in red 3-ring binders.

C. Electronic copy of AutoCAD as-built drawings shall also be provided on CD, with each O&M Manual.

3.21 FIELD QUALITY CONTROL

A. Flush, test and inspect sprinkler piping according to NFPA 13, "System Acceptance" Chapter.

B. Replace piping system components that do not pass test procedures and retest to demonstrate compliance. Repeat procedure until satisfactory results are obtained.

C. Report test results promptly and in writing to Architect and authorities having jurisdiction.

END OF SECTION 211000

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. This Section includes the following:
1. Piping materials and installation instructions common to most piping systems.
2. Transition fittings.
3. Dielectric fittings.
4. Mechanical sleeve seals.
5. Sleeves.
6. Escutcheons.
7. Grout.
8. Equipment installation requirements common to equipment sections.
9. Painting and finishing.
10. Concrete bases.
11. Supports and anchorages.
12. Link Seal

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, and crawlspaces.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms, accessible pipe shafts, accessible plumbing chases and accessible tunnels.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for rubber materials:
   1. EPDM: Ethylene-propylene-diene terpolymer rubber.
   2. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

A. Product Data: For the following:
   1. Transition fittings.
   2. Dielectric fittings.
   3. Mechanical sleeve seals.
   4. Escutcheons.

B. Welding certificates.

1.5 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for plumbing installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

B.

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

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. Refer to individual Division 22 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

2.4 TRANSITION FITTINGS

A. Flexible Transition Couplings for Underground Nonpressure Drainage Piping: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.

1. Manufacturers:

a. Cascade Waterworks Mfg. Co.
b. Fernco, Inc.
c. Mission Rubber Company.
d. Plastic Oddities, Inc.

2.5 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.

1. Manufacturers:

a. Capitol Manufacturing Co.
b. Central Plastics Company.
c. Eclipse, Inc.
d. Epco Sales, Inc.
e. Hart Industries, International, Inc.
f. Watts Industries, Inc.; Water Products Div.
g. Zurn Industries, Inc.; Wilkins Div.

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

1. Manufacturers:

a. Capitol Manufacturing Co.
b. Central Plastics Company.
c. Epco Sales, Inc.
d. Watts Industries, Inc.; Water Products Div.

E. Dielectric-Flange Kits: 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.

1. Manufacturers:

a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Central Plastics Company.
d. Pipeline Seal and Insulator, Inc.

2. 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: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

1. Manufacturers:

a. Calpico, Inc.
b. Lochinvar Corp.

G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

1. Manufacturers:

a. Perfection Corp.
b. Precision Plumbing Products, Inc.
c. Sioux Chief Manufacturing Co., Inc.
d. Victaulic Co. of America.

2.6 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

1. Manufacturers:

a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Metraflex Co.
d. Pipeline Seal and Insulator, Inc.

2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

3. Pressure Plates: Stainless steel. Include two for each sealing element.
4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.7 SLEEVES

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

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with set screws.

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

2.8 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Floor-Plate Type: Cast-iron floor plate.

D. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.9 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

2.10 LINK SEAL

A. Link-Seal® Modular Seal Pressure Plates

1. Link-Seal® modular seal pressure plates shall be molded of glass reinforced Nylon Polymer with the following properties:

   a. Izod Impact - Notched = 2.05ft-lb/in. per ASTM D-256
      Flexural Strength @ Yield = 30,750 psi per ASTM D-790
      Flexural Modulus = 1,124,000 psi per ASTM D-790
      Elongation Break = 11.07% per ASTM D-638
      Specific Gravity = 1.38 per ASTM D-792

2. Models LS200-275-300-315 shall incorporate the most current Link-Seal® Modular Seal design modifications and shall include an integrally molded compression assist boss on the top (bolt entry side) of the pressure plate, which permits increased compressive loading of the rubber sealing element. Models 315-325-340-360-400-410-425-475-500-525-575-600 shall incorporate an integral recess known as a “Hex Nut Interlock” designed to accommodate commercially available fasteners to insure proper thread engagement for the class and service of metal hardware. All pressure plates shall have a permanent identification of the manufacturer’s name molded into it.
3. For fire and Hi-Temp service, pressure plates shall be steel with 2-part Zinc Dichromate Coating.
4. Link-Seal® Modular Seal Hardware: All fasteners shall be sized according to latest Link-Seal® modular seal technical data. Bolts, flange hex nuts shall be: 316 Stainless Steel per ASTM F593-95, with a 85,000 psi average tensile strength.

PART 3 - EXECUTION

3.1 SEISMIC REQUIREMENTS

A. Comply with SEI/ASCE 7 and with requirements for seismic seismic-restraint devices in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

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

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

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

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

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

J. Install piping to allow application of insulation.

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

L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:

1. New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
c. Insulated Piping: One-piece, stamped-steel type with spring clips.
d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
f. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

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

N. Permanent sleeves are not required for holes formed by removable PE sleeves.

O. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.

P. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.

1. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

   a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
   b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
   c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.

      1) Seal space outside of sleeve fittings with grout.

4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

Q. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Install steel pipe for sleeves smaller than 6 inches in diameter.
2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

R. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

S. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.

T. Verify final equipment locations for roughing-in.

U. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.3 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.

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

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

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

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

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

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.4 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

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

3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.5 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

3.6 PAINTING

A. Painting of plumbing systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.7 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.8 GROUTING

A. Mix and install grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

END OF SECTION 220500

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SECTION 220517 - SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Sleeves.
2. Sleeve-seal systems.
3. Grout.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Galvanized-Steel Wall Pipes: ASTM A 53, Schedule 40, with plain ends and welded steel collar; zinc coated.

C. Galvanized-Steel-Pipe Sleeves: ASTM A 53, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

D. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

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

2.2 SLEEVE-SEAL SYSTEMS

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

1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. Link-Seal
4. Metraflex Company (The).
5. Pipeline Seal and Insulator, Inc.
6. Proco Products, Inc.

B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Carbon steel.
3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.3 GROUT

A. Standard: ASTM C 1107, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

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

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

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

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

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

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

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

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

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

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Division 07 Section "Joint Sealants."

E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07 Section "Penetration Firestopping."

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

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

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

3.3 SLEEVE AND SLEEVE-SEAL SCHEDULE

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

1. Exterior Concrete Walls above Grade:

    a. Piping Smaller Than NPS 6: Cast-iron wall sleeves.
    b. Piping NPS 6 and Larger: Cast-iron wall sleeves.

2. Exterior Concrete Walls below Grade:

    a. Piping Smaller Than NPS 6: Cast-iron wall sleeves with sleeve-seal system.

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

b. Piping NPS 6 and Larger: Cast-iron wall sleeves with sleeve-seal system.

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

3. Concrete Slabs-on-Grade:

a. Piping Smaller Than NPS 6: Cast-iron wall sleeves with sleeve-seal system.

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

b. Piping NPS 6 and Larger: Cast-iron wall sleeves with sleeve-seal system

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

4. Concrete Slabs above Grade:

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

5. Interior Partitions:

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

END OF SECTION 220517

SECTION 220518 - ESCUTCHEONS 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. Escutcheons.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

A. One-Piece, Cast-Brass Type: With polished, chrome-plated 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.

PART 3 - EXECUTION

3.1 INSTALLATION

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

B. Install escutcheons with ID to 2 inch (50mm), tube, and insulation of insulated 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 with polished, chrome-plated finish.
b. Chrome-Plated Piping: One-piece, cast-brass type with polished, chrome-plated finish.
c. Insulated Piping: One-piece, stamped-steel type with chrome-plated finish.
d. Bare Piping 2 inch and Smaller at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
e. Bare Piping Larger than 2 inch at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type with polished, chrome-plated finish.
f. Bare Piping 2 inch and Smaller at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
g. Bare Piping Larger than 2 inch at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type with polished, chrome-plated finish.
h. Bare Piping 2 inch and Smaller in Unfinished Service Spaces: One-piece, cast-brass type with polished, chrome-plated or rough-brass finish.
i. Bare Piping Larger than 2 inch in Unfinished Service Spaces: One-piece, stamped-steel type with polished, chrome-plated finish
j. Bare Piping 2 inch and Smaller in Equipment Rooms: One-piece, cast-brass type with polished, chrome-plated or rough-brass finish.
k. Bare Piping in Equipment Rooms Larger than 2 inch: One-piece, stamped-steel type with chrome- or cadmium-plated finish.

3.2 FIELD QUALITY CONTROL

A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION 220518

SECTION 220519 - METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Bimetallic-actuated thermometers.
2. Liquid-in-glass thermometers.
3. Thermowells.
4. Dial-type pressure gages.
5. Gage attachments.

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

A. Product certificates.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 BIMETALLIC-ACTUATED THERMOMETERS

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

1. Ashcroft Inc.
2. Ernst Flow Industries.
3. Marsh Bellofram.
4. Miljoco Corporation.
5. Nanmac Corporation.
6. Noshok.
7. Palmer Wahl Instrumentation Group.
8. REOTEMP Instrument Corporation.
9. Tel-Tru Manufacturing Company.

10. Trerice, H. O. Co.
11. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
12. Weiss Instruments, Inc.
13. WIKA Instrument Corporation - USA.
14. Winters Instruments - U.S.

B. Standard: ASME B40.200.

C. Case: Liquid-filled and sealed type(s); stainless steel with 5-inch (96-mm) nominal diameter.

D. Dial: Nonreflective aluminum with permanently etched scale markings and scales in deg F and deg C.

E. Connector Type(s): Union joint, adjustable angle, with unified-inch screw threads.

F. Connector Size: 1/2 inch (13 mm)], with ASME B1.1 screw threads.

G. Stem: 0.25 or 0.375 inch (6.4 or 9.4 mm) in diameter; stainless steel.

H. Window: Plain glass or plastic.

I. Ring: Stainless steel.

J. Element: Bimetal coil.

K. Pointer: Dark-colored metal.

L. Accuracy: Plus or minus 1 percent of scale range.

2.2 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:

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

   a. Flo Fab Inc.
   b. Miljoco Corporation.
   c. Palmer Wahl Instrumentation Group.
   d. Tel-Tru Manufacturing Company.
   e. Trerice, H. O. Co.
   f. Weiss Instruments, Inc.
   g. Winters Instruments - U.S.

2. Standard: ASME B40.200.
3. Case: Cast aluminum 7-inch (178-mm) 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 and deg C.
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 (32 mm), with ASME B1.1 screw threads.
10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.3 THERMOWELLS

A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing: CNR or CUNI.
4. Material for Use with Steel Piping: CRES.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, (DN 15,) ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2, (13, mm), 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.

C. Description: Pressure-tight, socket-type metal fitting made for insertion into piping and of type, diameter, and length required to hold thermometer.

2.4 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

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

    a. AMETEK, Inc.; U.S. Gauge.
    b. Ashcroft Inc.
    c. Ernst Flow Industries.
    d. Flo Fab Inc.
    e. Marsh Bellofram.

f. Miljoco Corporation.
g. Noshok.
h. Palmer Wahl Instrumentation Group.
i. REOTEMP Instrument Corporation.
j. Tel-Tru Manufacturing Company.
k. Trerice, H. O. Co.
l. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
m. Weiss Instruments, Inc.
n. WIKA Instrument Corporation - USA.
o. Winters Instruments - U.S.

2. Standard: ASME B40.100.
3. Case: Liquid-filled Open-front, pressure relief 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 (DN 8 or DN 15), 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 and kPa.
8. Pointer: Dark-colored metal.
9. Window: Glass or plastic.
10. Ring: Metal or Brass.
11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.5 GAGE ATTACH TEST PLUGS

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

1. Flow Design, Inc.
2. MG Piping Products Co.
3. National Meter, Inc.
4. Peterson Equipment Co., Inc.
5. Sisco Manufacturing Co.
6. Trerice, H. O. Co.
7. Weksler.
8. Watts Industries, Inc.; Water Products Div.

B. Description: Corrosion-resistant brass or stainless-steel body with core inserts and gasketed and threaded cap, with extended stem for units to be installed in insulated piping.

C. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.

D. Core Inserts: One or two self-sealing rubber valves.

1. Insert material for water service at 20 to 200 deg F shall be CR.
2. Insert material for water service at minus 30 to plus 275 deg F shall be EPDM.

E. Test Kit: Furnish one test kit(s) containing one pressure gage and adaptor, one thermometer, and carrying case. Pressure gage, adapter probes, and thermometer sensing elements shall be of diameter to fit test plugs and of length to project into piping.

1. Pressure Gage: Small bourdon-tube insertion type with 2- to 3-inch- diameter dial and probe. Dial range shall be 0 to 200 psig.
2. Low-Range Thermometer: Small bimetallic insertion type with 1- to 2-inch- diameter dial and tapered-end sensing element. Dial ranges shall be 25 to 125 deg F.
3. High-Range Thermometer: Small bimetallic insertion type with 1- to 2-inch- diameter dial and tapered-end sensing element. Dial ranges shall be 0 to 220 deg F.
4. Carrying case shall have formed instrument padding.

2.6 ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2 (DN 8 or DN 15)] , ASME B1.20.1 pipe threads and piston porous-metal-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 (DN 8 or DN 15), ASME B1.20.1 pipe threads.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install thermowells with socket extending a minimum of 2 inches (51 mm) into fluid one-third of pipe diameter 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 thermometers in the following locations:

1. Inlet and outlet of each water heater.

I. Install pressure gages in the following locations:

1. Building water service entrance into building.
2. Inlet and outlet of each pressure-reducing valve.
3. Suction and discharge of each domestic water pump.

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

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

L. Install remote-mounting dial thermometers on panel, with tubing connecting panel and thermometer bulb supported to prevent kinds. Use minimum tubing length.

M. Install test plugs in tees in piping.

N. Install permanent indicator on walls or brackets in accessible and readable positions.

3.2 THERMOMETER SCHEDULE

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

1. Liquid-filled Sealed, bimetallic-actuated type.
2. Industrial-style, liquid-in-glass type.

B. Thermometers at inlets and outlets of each domestic water heat exchanger shall be one of the following:

1. Liquid-filled Sealed, bimetallic-actuated type.
2. Industrial-style, liquid-in-glass type.

C. Thermometers at inlet and outlet of each domestic hot-water storage tank shall be one of the following:

1. Liquid-filled Sealed, bimetallic-actuated type.
2. Industrial-style, liquid-in-glass type.

D. Thermometer stems shall be of length to match thermowell insertion length.

3.3 THERMOMETER SCALE-RANGE SCHEDULE

A. Scale Range for Domestic Cold-Water Piping: 0 to 150 deg F and minus 20 to plus 70 deg C.

B. Scale Range for Domestic Hot-Water Piping: 20 to 240 deg F and 0 to 150 deg C.

3.4 PRESSURE-GAGE SCHEDULE

A. Pressure gages at discharge of each water service into building shall be one of the following:

1. Liquid-filled Sealed Open-front, pressure-relief, direct-mounted, metal case.

B. Pressure gages at inlet and outlet of each water pressure-reducing valve shall be one of the following:

1. Liquid-filled Sealed Open-front, pressure-relief, direct mounted, metal case.

C. Pressure gages at suction and discharge of each domestic water pump shall be one of the following:

1. Liquid-filled Sealed Open-front, pressure-relief , direct-mounted, metal case.

3.5 PRESSURE-GAGE SCALE-RANGE SCHEDULE

A. Scale Range for Water Service Piping 0 to 160 psi and 0 to 1100 kPa.

B. Scale Range for Domestic Water Piping: 0 to 160 psi and 0 to 1100 kPa.

END OF SECTION 220519

SECTION 220523 - GENERAL-DUTY 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 angle valves.
2. Bronze ball valves.
3. Iron, single-flange butterfly valves.
4. Bronze lift check valves.
5. Bronze swing check valves.
6. Iron swing check valves.
7. Iron swing check valves with closure control.
8. Bronze gate valves.
9. Bronze globe valves.
10. Iron globe valves.
11. Chainwheels.

B. Related Sections:

1. Division 22 plumbing piping Sections for specialty valves applicable to those Sections only.
2. Division 22 Section "Identification for Plumbing Piping and Equipment" for valve tags and schedules.
3. Division 33 water distribution piping Sections for general-duty and specialty valves for site construction piping.

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.

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

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 and plug 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 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 except plug valves.
4. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 5 plug valves, for each size square plug-valve head.
5. 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. 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.
2. 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 ANGLE VALVES

A. Class 125, Bronze Angle Valves with Bronze Disc:

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

a. Hammond Valve.
b. Milwaukee Valve Company.

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.
e. Stem and Disc: Bronze.
f. Packing: Asbestos free.
g. Handwheel: Malleable iron, bronze, or aluminum.

2.3 BRONZE BALL VALVES

A. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:

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

a. American Valve, Inc.
b. Conbraco Industries, Inc.; Apollo Valves.
c. Crane Co.; Crane Valve Group; Crane Valves.
d. Hammond Valve.
e. Lance Valves; a division of Advanced Thermal Systems, Inc.
f. Legend Valve.
g. Milwaukee Valve Company.
h. NIBCO INC.
i. Red-White Valve Corporation.
j. 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.

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

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

a. Conbraco Industries, Inc.; Apollo Valves.
b. Crane Co.; Crane Valve Group; Crane Valves.
c. Hammond Valve.

d. Lance Valves; a division of Advanced Thermal Systems, Inc.
e. Milwaukee Valve Company.
f. NIBCO INC.
g. 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: Stainless steel.
i. Ball: Stainless steel, vented.
j. Port: Full.

C. Two-Piece, Regular-Port, Bronze Ball Valves with Bronze Trim:

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

a. American Valve, Inc.
b. Conbraco Industries, Inc.; Apollo Valves.
c. Crane Co.; Crane Valve Group; Jenkins Valves.
d. Crane Co.; Crane Valve Group; Stockham Division.
e. DynaQuip Controls.
f. Hammond Valve.
g. Lance Valves; a division of Advanced Thermal Systems, Inc.
h. Milwaukee Valve Company.
i. NIBCO 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: Regular.

D. Two-Piece, Regular-Port, Bronze Ball Valves with Stainless-Steel Trim:

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

    a. Conbraco Industries, Inc.; Apollo Valves.
    b. Crane Co.; Crane Valve Group; Jenkins Valves.
    c. Hammond Valve.
    d. Milwaukee Valve Company.

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: Stainless steel.
    i. Ball: Stainless steel, vented.
    j. Port: Regular.

E. Three-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:

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

    a. Conbraco Industries, Inc.; Apollo Valves.
    b. DynaQuip Controls.
    c. Hammond Valve.
    d. Milwaukee Valve Company.
    e. NIBCO INC.
    f. Red-White Valve Corporation.

2. Description:

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

F. Three-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:

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

   a. Conbraco Industries, Inc.; Apollo Valves.
   b. Hammond Valve.
   c. Milwaukee Valve Company.
   d. NIBCO INC.

2. Description:

   a. Standard: MSS SP-110.
   b. SWP Rating: 150 psig.
   c. CWP Rating: 600 psig.
   d. Body Design: Three piece.
   e. Body Material: Bronze.
   f. Ends: Threaded.
   g. Seats: PTFE or TFE.
   h. Stem: Stainless steel.
   i. Ball: Stainless steel, vented.
   j. Port: Full.

2.4 IRON, SINGLE-FLANGE BUTTERFLY VALVES

A. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum-Bronze Disc:

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

   a. ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
   b. Conbraco Industries, Inc.; Apollo Valves.
   c. Cooper Cameron Valves; a division of Cooper Cameron Corporation.
   d. Crane Co.; Crane Valve Group; Jenkins Valves.
   e. Crane Co.; Crane Valve Group; Stockham Division.
   f. DeZurik Water Controls.
   g. Flo Fab Inc.
   h. Hammond Valve.
   i. Kitz Corporation.
   j. Legend Valve.
   k. Milwaukee Valve Company.
   l. NIBCO INC.
   m. Norriseal; a Dover Corporation company.
   n. Red-White Valve Corporation.
   o. Spence Strainers International; a division of CIRCOR International, Inc.
   p. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-67, Type I.
b. CWP Rating: 200 psig.
c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
e. Seat: EPDM.
f. Stem: One- or two-piece stainless steel.
g. Disc: Aluminum bronze.

B. 200 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Aluminum-Bronze Disc:

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

a. ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
b. Conbraco Industries, Inc.; Apollo Valves.
c. Cooper Cameron Valves; a division of Cooper Cameron Corporation.
d. Crane Co.; Crane Valve Group; Jenkins Valves.
e. Crane Co.; Crane Valve Group; Stockham Division.
f. DeZurik Water Controls.
g. Flo Fab Inc.
h. Hammond Valve.
i. Kitz Corporation.
j. Legend Valve.
k. Milwaukee Valve Company.
l. NIBCO INC.
m. Norriseal; a Dover Corporation company.
n. Red-White Valve Corporation.
o. Spence Strainers International; a division of CIRCOR International, Inc.
p. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-67, Type I.
b. CWP Rating: 200 psig.
c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
e. Seat: NBR.
f. Stem: One- or two-piece stainless steel.
g. Disc: Aluminum bronze.

C. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Ductile-Iron Disc:

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

a. ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.

b. American Valve, Inc.
c. Conbraco Industries, Inc.; Apollo Valves.
d. Cooper Cameron Valves; a division of Cooper Cameron Corporation.
e. Crane Co.; Crane Valve Group; Center Line.
f. Crane Co.; Crane Valve Group; Stockham Division.
g. DeZurik Water Controls.
h. Flo Fab Inc.
i. Hammond Valve.
j. Kitz Corporation.
k. Legend Valve.
l. Milwaukee Valve Company.
m. Mueller Steam Specialty; a division of SPX Corporation.
n. NIBCO INC.
o. Norriseal; a Dover Corporation company.
p. Spence Strainers International; a division of CIRCOR International, Inc.
q. Sure Flow Equipment Inc.
r. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-67, Type I.
b. CWP Rating: 200 psig.
c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
e. Seat: EPDM.
f. Stem: One- or two-piece stainless steel.
g. Disc: Nickel-plated or -coated ductile iron.

D. 200 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Ductile-Iron Disc:

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

a. ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
b. American Valve, Inc.
c. Conbraco Industries, Inc.; Apollo Valves.
d. Cooper Cameron Valves; a division of Cooper Cameron Corporation.
e. Crane Co.; Crane Valve Group; Center Line.
f. Crane Co.; Crane Valve Group; Stockham Division.
g. DeZurik Water Controls.
h. Flo Fab Inc.
i. Hammond Valve.
j. Kitz Corporation.
k. Legend Valve.
l. Milwaukee Valve Company.
m. Mueller Steam Specialty; a division of SPX Corporation.
n. NIBCO INC.

o. Norriseal; a Dover Corporation company.
p. Spence Strainers International; a division of CIRCOR International, Inc.
q. Sure Flow Equipment Inc.
r. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-67, Type I.
b. CWP Rating: 200 psig.
c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
e. Seat: NBR.
f. Stem: One- or two-piece stainless steel.
g. Disc: Nickel-plated ductile iron.

E. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Stainless-Steel Disc:

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

a. ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
b. American Valve, Inc.
c. Conbraco Industries, Inc.; Apollo Valves.
d. Cooper Cameron Valves; a division of Cooper Cameron Corporation.
e. Crane Co.; Crane Valve Group; Jenkins Valves.
f. Crane Co.; Crane Valve Group; Stockham Division.
g. DeZurik Water Controls.
h. Flo Fab Inc.
i. Hammond Valve.
j. Kitz Corporation.
k. Legend Valve.
l. Milwaukee Valve Company.
m. Mueller Steam Specialty; a division of SPX Corporation.
n. NIBCO INC.
o. Norriseal; a Dover Corporation company.
p. Red-White Valve Corporation.
q. Spence Strainers International; a division of CIRCOR International, Inc.
r. Sure Flow Equipment Inc.
s. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-67, Type I.
b. CWP Rating: 200 psig.
c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.

e. Seat: EPDM.
f. Stem: One- or two-piece stainless steel.
g. Disc: Stainless steel.

F. 200 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Stainless-Steel Disc:

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

a. ABZ Valves and Controls; A div. of ABZ Manufacturing, Inc.
b. American Valve, Inc.
c. Conbraco Industries, Inc.; Apollo Valves.
d. Cooper Cameron Valves; A div. of Cooper Cameron Corp.
e. Crane Co.; Crane Valve Group; Jenkins Valves.
f. Crane Co.; Crane Valve Group; Stockham Div.
g. DeZurik Water Controls.
h. Flo Fab Inc.
i. Hammond Valve.
j. Kitz Corporation.
k. Legend Valve.
l. Milwaukee Valve Company.
m. Mueller Steam Specialty; a division of SPX Corporation.
n. NIBCO INC.
o. Norriseal; a Dover Corporation company.
p. Red-White Valve Corporation.
q. Spence Strainers International; a division of CIRCOR International, Inc.
r. Sure Flow Equipment Inc.
s. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-67, Type I.
b. CWP Rating: 200 psig.
c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
e. Seat: NBR.
f. Stem: One- or two-piece stainless steel.
g. Disc: Stainless steel.

2.5 IRON, GROOVED-END BUTTERFLY VALVES

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

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

a. Kennedy Valve; a division of McWane, Inc.
b. Shurjoint Piping Products.
c. Tyco Fire Products LP; Grinnell Mechanical Products.
d. Victaulic Company.

2. Description:

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

2.6 BRONZE LIFT CHECK VALVES

A. Class 125, Lift Check Valves with Bronze Disc:

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

a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Crane Co.; Crane Valve Group; Stockham Division.

2. Description:

a. Standard: MSS SP-80, Type 1.
b. CWP Rating: 200 psig.
c. Body Design: Vertical flow.
d. Body Material: ASTM B 61 or ASTM B 62, bronze.
e. Ends: Threaded.
f. Disc: Bronze.

2.7 BRONZE SWING CHECK VALVES

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

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

a. American Valve, Inc.
b. Crane Co.; Crane Valve Group; Crane Valves.
c. Crane Co.; Crane Valve Group; Jenkins Valves.
d. Crane Co.; Crane Valve Group; Stockham Division.
e. Hammond Valve.

f. Kitz Corporation.
g. Milwaukee Valve Company.
h. NIBCO INC.
i. Powell Valves.
j. Red-White Valve Corporation.
k. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
l. Zy-Tech Global Industries, Inc.

2. Description:

a. Standard: MSS SP-80, Type 3.
b. CWP Rating: 200 psig.
c. Body Design: Horizontal flow.
d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded.
f. Disc: Bronze.

B. Class 150, Bronze Swing Check Valves with Bronze Disc:

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

a. American Valve, Inc.
b. Crane Co.; Crane Valve Group; Crane Valves.
c. Crane Co.; Crane Valve Group; Jenkins Valves.
d. Crane Co.; Crane Valve Group; Stockham Division.
e. Kitz Corporation.
f. Milwaukee Valve Company.
g. NIBCO INC.
h. Red-White Valve Corporation.
i. Zy-Tech Global Industries, Inc.

2. Description:

a. Standard: MSS SP-80, Type 3.
b. CWP Rating: 300 psig.
c. Body Design: Horizontal flow.
d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded.
f. Disc: Bronze.

2.8 IRON SWING CHECK VALVES

A. Class 125, Iron Swing Check Valves with Metal Seats:

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

a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Crane Co.; Crane Valve Group; Stockham Division.
d. Hammond Valve.
e. Kitz Corporation.
f. Legend Valve.
g. Milwaukee Valve Company.
h. NIBCO INC.
i. Powell Valves.
j. Red-White Valve Corporation.
k. Sure Flow Equipment Inc.
l. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
m. Zy-Tech Global Industries, Inc.

2. Description:

a. Standard: MSS SP-71, Type I.
b. CWP Rating: 200 psig.
c. Body Design: Clear or full waterway.
d. Body Material: ASTM A 126, gray iron with bolted bonnet.
e. Ends: Flanged.
f. Trim: Bronze.
g. Gasket: Asbestos free.

B. Class 250, Iron Swing Check Valves with Metal Seats:

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

a. Crane Co.; Crane Valve Group; 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-71, Type I.
b. CWP Rating: 500 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.

2.9 IRON SWING CHECK VALVES WITH CLOSURE CONTROL

A. Class 125, Iron Swing Check Valves with Lever- and Spring-Closure Control:

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

   a. NIBCO INC.

2. Description:

   a. Standard: MSS SP-71, Type I.
   b. CWP Rating: 200 psig.
   c. Body Design: Clear or full waterway.
   d. Body Material: ASTM A 126, gray iron with bolted bonnet.
   e. Ends: Flanged.
   f. Trim: Bronze.
   g. Gasket: Asbestos free.
   h. Closure Control: Factory-installed, exterior lever and spring.

2.10 BRONZE GLOBE VALVES

A. Class 125, Bronze Globe Valves with Bronze Disc:

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

   a. Crane Co.; Crane Valve Group; Crane Valves.
   b. Crane Co.; Crane Valve Group; Stockham Division.
   c. Hammond Valve.
   d. Kitz Corporation.
   e. Milwaukee Valve Company.
   f. NIBCO INC.
   g. Powell Valves.
   h. Red-White Valve Corporation.
   i. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   j. Zy-Tech Global Industries, 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 and Disc: Bronze.
   f. Packing: Asbestos free.
   g. Handwheel: Malleable iron, bronze, or aluminum.

2.11 IRON GLOBE VALVES

A. Class 125, Iron Globe Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of 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. Kitz Corporation.
   f. Milwaukee Valve Company.
   g. NIBCO INC.
   h. Powell Valves.
   i. Red-White Valve Corporation.
   j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   k. Zy-Tech Global Industries, 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.

2.12 CHAINWHEELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of 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 ball butterfly and plug valve stems.
   3. Sprocket Rim with Chain Guides: Aluminum, 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 ball butterfly gate globe and plug valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inchesabove 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.
2. Lift Check Valves: With stem upright and plumb.

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, or butterfly valves.
2. Butterfly Valve Dead-End Service: Single-flange (lug) type.
3. Throttling Service Globe, angle, ball or butterfly valves.
4. Pump-Discharge Check Valves:

   a. NPS 2 and Smaller: Bronze swing check valves with bronze disc.
   b. NPS 2-1/2 and Larger for Domestic Water: Iron swing check valves with lever and weight or with spring or iron, center-guided, metal or resilient-seat check valves.
   c. NPS 2-1/2 and Larger for Sanitary Waste and Storm Drainage: Iron swing check valves with lever and weight or spring.

B. If valves with specified 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.

3.5 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
2. Bronze Angle Valves: Class 125 or Class 150, bronze disc.
3. Ball Valves: One, Two or Three piece, full or, regular port, bronze with bronze or stainless-steel trim.
4. Bronze Swing Check Valves: Class 125 or Class 150, bronze disc.
5. Bronze Globe Valves: Class 125 or Class 150, bronze 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. Ball Valves: One, Two or Three piece, full or, regular port, bronze with bronze or stainless-steel trim.
3. Iron, Single-Flange Butterfly Valves: 200 CWP, EPDM or NBR seat, aluminum-bronze, ductile-iron or stainless-steel disc.
4. Iron Swing Check Valves: Class 125 or Class 250, metal seats.
5. Iron Swing Check Valves with Closure Control: Class 125, lever and spring weight.

6. Iron Globe Valves: Class 125 or Class 250.

END OF SECTION 220523

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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. This Section includes the following hangers and supports for plumbing system piping and equipment:

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

B. Related Sections include the following:

1. Division 05 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Division 21 Section "Water-Based Fire-Suppression Systems" for pipe hangers for fire-suppression piping.
3. Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for vibration isolation devices.

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc.

B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 SEISMIC REQUIREMENTS

A. Component Importance Factor. All plumbing components shall be assigned a component importance factor. The component importance factor, I_p, shall be taken as 1.5 if any of the following conditions apply:

1. The component is required to function for life-safety purposes after an earthquake.
2. The component contains hazardous materials.
3. The component is in or attached to an Occupancy Category IV structure and it is needed for continued operation of the facility or its failure could impair the continued operation of the facility.

B. All other components shall be assigned a component importance factor, I*p*, equal to 1.0.

1.5 PERFORMANCE REQUIREMENTS

A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

C. Seismic Performance: Plumbing equipment, hangers and supports shall withstand the effects of earthquake motions determined according to SEI/ASCE 7 and with the requirements specified in Section 220548 " Vibration and Seismic Controls for Plumbing Piping and Equipment.

1. For components with a seismic importance factor of 1.0 the term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified."

2. For components with a seismic importance factor of 1.5 the term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified and the system will be fully operational after the seismic event."

1.6 SUBMITTALS

A. Product Data: For the following:

1. Steel pipe hangers and supports.
2. Thermal-hanger shield inserts.
3. Powder-actuated fastener systems.
4. Pipe positioning systems.
5. Mechanical Anchors: ICC-ES Evaluation Reports validating ‘Cracked Concrete’ testing per A.C. 193 must be provided for anchors resisting seismic loads and/or supporting life-safety systems including fire sprinkler systems.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:

1. Trapeze pipe hangers. Include Product Data for components.
2. Pipe stands. Include Product Data for components.
3. Equipment supports.

C. Welding certificates.

D. Delegated-Design Submittal:

1. Design calculations and detailed fabrication and assembly of pipe anchors and alignment guides, hangers and supports for multiple pipes, expansion joints and loops, and attachments of the same to the building structure.
2. Locations of pipe anchors and alignment guides and expansion joints and loops.
3. Locations of and details for penetrations, including sleeves and sleeve seals for exterior walls, floors, basement, and foundation walls.
4. Seismic calculations and detailed analysis: Indicate fabrication and arrangement. Detail attachments of restraints to the 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. Project specific design documentation and calculations shall be prepared and stamped by a registered professional engineer who is responsible for the seismic restraint design and who is licensed in the state where the project is being constructed (ASCE 7, 13.2.1.1).

1.7 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel.", AWS D1.4, "Structural Welding Code--Reinforcing Steel." and ASME Boiler and Pressure Vessel Code: Section IX.

B. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code--Steel."
2. AWS D1.2, "Structural Welding Code--Aluminum."
3. AWS D1.4, "Structural Welding Code--Reinforcing Steel."
4. ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

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

2.2 STEEL PIPE HANGERS AND SUPPORTS

A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.

B. Manufacturers:

1. Anvil International.
2. AAA Technology & Specialties Co., Inc.
3. Bergen-Power Pipe Supports.
4. B-Line Systems, Inc.; a division of Cooper Industries.
5. Carpenter & Paterson, Inc.
6. Empire Industries, Inc.
7. ERICO/Michigan Hanger Co.
8. Globe Pipe Hanger Products, Inc.
9. Grinnell Corp.
10. GS Metals Corp.
11. National Pipe Hanger Corporation.
12. PHD Manufacturing, Inc.
13. PHS Industries, Inc.
14. Piping Technology & Products, Inc.
15. Tolco Inc.
16. Simpson Strong-Tie Co.

C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.3 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.4 THERMAL-HANGER SHIELD INSERTS

A. Description: 100-psig- minimum, compressive-strength insulation insert encased in sheet metal shield.

B. Manufacturers:

1. Carpenter & Paterson, Inc.
2. ERICO/Michigan Hanger Co.

3. PHS Industries, Inc.
4. Pipe Shields, Inc.
5. Rilco Manufacturing Company, Inc.
6. Value Engineered Products, Inc.

C. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with vapor barrier.

D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate.

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

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

G. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.5 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:

a. Hilti, Inc.
b. MKT Fastening, LLC.
c. Powers Fasteners.
d. Simpson Strong-Tie Co.

B. Mechanical-Expansion Anchors and Concrete Screws: Insert-wedge-type stainless steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used. For anchors resisting seismic loads and/or supporting life- safety systems including fire sprinkler systems, Anchors shall have been tested for ‘Cracked Concrete’ per A.C. 193 per a valid ICC-ES Evaluation Report. Manufacturers with these anchors have been designated below with: ‘*’

1. Manufacturers:

a. B-Line Systems, Inc.; a division of Cooper Industries.
b. Empire Industries, Inc.
c. Hilti, Inc.
d. ITW Ramset/Red Head.
e. MKT Fastening, LLC.
f. Powers Fasteners.
g. Simpson Strong-Tie Co. *

2.6 PIPE STAND FABRICATION

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

B. Compact Pipe Stand: One-piece plastic unit with integral-rod-roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

1. Manufacturers:

a. Anvil International.
b. ERICO/Michigan Hanger Co.
c. MIRO Industries.
d. Unipure

C. Low-Type, Single-Pipe Stand: One-piece stainless-steel base unit with plastic roller, for roof installation without membrane penetration.

1. Manufacturers:

a. MIRO Industries.

D. High-Type, Single-Pipe Stand: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.

1. Manufacturers:

a. Anvil International.
b. ERICO/Michigan Hanger Co.
c. MIRO Industries.
d. Portable Pipe Hangers.

2. Base: Stainless steel.
3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.

E. High-Type, Multiple-Pipe Stand: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.

1. Manufacturers:

a. Anvil International.
b. Portable Pipe Hangers.

2. Bases: One or more plastic.
3. Vertical Members: Two or more protective-coated-steel channels.

4. Horizontal Member: Protective-coated-steel channel.
5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

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

2.7 PIPE POSITIONING SYSTEMS

A. Description: IAPMO PS 42, system of metal brackets, clips, and straps for positioning piping in pipe spaces for plumbing fixtures for commercial applications.

B. Manufacturers:

1. C & S Mfg. Corp.
2. HOLDRITE Corp.; Hubbard Enterprises.
3. Samco Stamping, Inc.

2.8 EQUIPMENT SUPPORTS

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

2.9 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

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

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.

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

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

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

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

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F pipes, NPS 4 to NPS 16, 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 24, requiring clamp flexibility and up to 4 inches of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24, if 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 2.
10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8.
11. Extension Hinged or 2-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.
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 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 2 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 20, 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.

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 20.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.

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

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

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

1. Steel or Malleable Concrete Inserts (MSS Type 18 or Simpson Blue Banger Concrete insert with UL & FM approvals): 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.

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

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

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

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb 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 absorb 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 absorb 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.

L. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.

M. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

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

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

3.2 HANGER AND SUPPORT INSTALLATION

A. Comply with SEI/ASCE 7 and with requirements for seismic-restraint devices in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

C. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

D. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.

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

F. 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. Powder actuated fasteners shall not be used for seismic bracing attachments.

2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions. For anchors resisting seismic loads and/or supporting life-safety systems including fire sprinkler systems, anchors shall have been tested for 'Cracked Concrete' per A.C. 193 and shall have a valid ICC-ES Evaluation Report

G. Pipe Stand Installation:

1. Pipe Stand Types except Curb-Mounting Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
2. Curb-Mounting-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. Refer to Division 07 Section "Roof Accessories" for curbs.

H. Pipe Positioning System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture. Refer to Division 22 Section "Plumbing Fixtures" for plumbing fixtures.

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

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

K. 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.

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

M. 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.

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

O. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9 (for building services piping) are not exceeded.

P. Insulated Piping: Comply with the following:

1. Attach clamps and spacers to piping.

a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.

b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
c. Do not exceed pipe stress limits according to ASME B31.9 for building services piping.

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

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

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

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

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

   a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
   b. NPS 4: 12 inches long and 0.06 inch thick.
   c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
   d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
   e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.

5. Pipes NPS 8 and Larger: Include wood inserts.
6. Insert Material: Length at least as long as protective shield.
7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

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

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

C. Provide lateral bracing, to prevent swaying, for equipment supports. For applications where seismic bracing is required, ‘Cracked Concrete’ expansion anchors or concrete screws tested per A.C. 193 must be provided for seismic bracing anchorage where post-installed anchors are required.

3.4 METAL FABRICATIONS

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

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

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

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

3.5 ADJUSTING

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

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

3.6 PAINTING

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

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Touch Up: 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.

END OF SECTION 220529

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SECTION 220548 - VIBRATION AND SEISMIC CONTROLS 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. This Section includes the following restraints and vibration isolation as defined in Section 230548 “Vibration Isolation and Seismic Controls for HVAC” for the following:

1. Plumbing Piping.
2. Plumbing Equipment.

PART 2 - PRODUCTS

2.1 (NOT USED)

PART 3 - EXECUTION

3.1 (NOT USED)

END OF SECTION 220548

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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. 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, 1/16 inch thick, and having predrilled holes for attachment hardware.
2. Letter Color: White.
3. Background Color: Blue.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

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

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: Black.

C. Background Color: Yellow.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater

viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless-steel rivets or self-tapping screws.

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

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

2.3 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. 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, pipe size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: At least 1-1/2 inches high.

2.4 STENCILS

A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; 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, alkyd enamel black unless otherwise indicated. Paint may be in pressurized spray-can form.
3. Identification Paint: Exterior, alkyd enamel in colors according to ASME A13.1 unless otherwise indicated.

2.5 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: Brass grommet and wire.
3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
4. Color: Yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 EQUIPMENT LABEL INSTALLATION

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

B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

A. Piping Color-Coding: Painting of piping is specified in Division 09.

B. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying with ASME A13.1, on each piping system.

1. Identification Paint: Use for contrasting background.
2. Stencil Paint: Use for pipe marking.

C. 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 feetalong 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.

D. Pipe Label Color Schedule:

1. Domestic Water Piping:

a. Background Color: Comply with ASME A13.1.
b. Letter Color: Comply with ASME A13.1.

2. Sanitary Waste and Storm Drainage Piping:

a. Background Color: Comply with ASME A13.1.
b. Letter Color: Comply with ASME A13.1.

3.4 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

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

1. Valve-Tag Size and Shape:

a. Cold Water: 1-1/2 inches, round.
b. Hot Water: 1-1/2 inches, round.

2. Valve-Tag Color:

a. Cold Water: Comply with ASME A13.1.
b. Hot Water: Comply with ASME A13.1.

3. Letter Color:

a. Cold Water: Comply with ASME A13.1.
b. Hot Water: Comply with ASME A13.1.

3.5 WARNING-TAG INSTALLATION

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

END OF SECTION 220553

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SECTION 220700 - PLUMBING 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. Flexible elastomeric.
   b. Mineral fiber.

2. Adhesives.
3. Lagging adhesives.
4. Sealants.
5. Factory-applied jackets.
6. Field-applied fabric-reinforcing mesh.
7. Field-applied jackets.
8. Tapes.
9. Securements.
10. Corner angles.

B. Related Sections include the following:

1. Division 23 Section "HVAC Insulation."

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.

C. Qualification Data: For qualified Installer.

D. 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.

E. 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 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application and equipment Installer for equipment insulation application. Before preparing piping Shop

Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

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

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

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in 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, provide one of 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 I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:

a. CertainTeed Corp.; Duct Wrap.
b. Johns Manville; Microlite.
c. 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 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, provide one of 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, provide one of 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. 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 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:

a. CertainTeed Corp.; CrimpWrap.
b. Johns Manville; MicroFlex.
c. Knauf Insulation; Pipe and Tank Insulation.
d. Manson Insulation Inc.; AK Flex.
e. Owens Corning; Fiberglas Pipe and Tank Insulation.

2.2 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Products: Subject to compliance with requirements, provide one of 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.

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

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Products, Division of ITW; CP-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.

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

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Products, Division of ITW; CP-82.
b. Foster Products Corporation, H. B. Fuller Company; 85-20.
c. ITW TACC, Division of Illinois Tool Works; S-90/80.
d. Marathon Industries, Inc.; 225.
e. Mon-Eco Industries, Inc.; 22-25.

E. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Products: Subject to compliance with requirements, provide one of 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. Red Devil, Inc.; Celulon Ultra Clear.
e. Speedline Corporation; Speedline Vinyl Adhesive.

2.3 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.

B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. 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. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Childers Products, Division of ITW; Encacel.
   b. Foster Products Corporation, H. B. Fuller Company; 60-95/60-96.
   c. Marathon Industries, Inc.; 570.
   d. Mon-Eco Industries, Inc.; 55-70.

2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
3. Service Temperature Range: Minus 50 to plus 220 deg F.
4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
5. Color: White.

2.4 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

1. Products: Subject to compliance with requirements, provide one of 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.
e. Vimasco Corporation; 136.

2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over equipment and pipe insulation.
3. Service Temperature Range: Minus 50 to plus 180 deg F.
4. Color: White.

2.5 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Products, Division of ITW; CP-76-8.
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.

B. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Products, Division of ITW; CP-76.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.

2.6 FACTORY-APPLIED JACKETS

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

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
4. PVDC Jacket for Indoor Applications: 4-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.

    a. Products: Subject to compliance with requirements, provide the following:

        1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.

5. PVDC Jacket for Outdoor Applications: 6-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.

    a. Products: Subject to compliance with requirements, provide the following:

        1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.

6. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.

    a. Products: Subject to compliance with requirements, provide the following:

        1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.

2.7 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, provide one of 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.

2.8 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. 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, provide one of 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, provide one of 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, provide one of 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.

E. PVDC Tape: White vapor-retarder PVDC tape with acrylic adhesive.

1. Products: Subject to compliance with requirements, provide the following:

   a. Dow Chemical Company (The); Saran 540 Vapor Retarder Tape.

2. Width: 3 inches.
3. Film Thickness: 4 mils.
4. Adhesive Thickness: 1.5 mils.
5. Elongation at Break: 145 percent.
6. Tensile Strength: 55 lbf/inch in width.

2.9 SECUREMENTS

A. Bands:

1. Products: Subject to compliance with requirements, provide one of 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, 1/2 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, 1/2 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, provide one of 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, provide one of 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, provide one of 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: Aluminum or Stainless 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, provide one of 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: Aluminum or Stainless 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, aluminum or stainless-steel] sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

a. Products: Subject to compliance with requirements, provide one of the following:

1) AGM Industries, Inc.; RC-150.
2) GEMCO; R-150.
3) Midwest Fasteners, Inc.; WA-150.
4) 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 or 0.062-inch soft-annealed, stainless steel.

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

a. C & F Wire.
b. Childers Products.
c. PABCO Metals Corporation.
d. RPR Products, Inc.

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. Surface Preparation: 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 between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

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

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

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment 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 and pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

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

I. Install insulation with least number of joints practical.

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

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

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

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

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

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

4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to 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 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 Division 07 Section "Penetration Firestopping"irestopping 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 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. 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 aluminum or stainless 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 and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, 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 Flanges:

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

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.8 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.

3.9 FIELD-APPLIED JACKET INSTALLATION

A. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

D. Where PVDC jackets are indicated, install as follows:

1. Apply three separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.
2. Wrap factory-presized jackets around individual pipe insulation sections with one end overlapping the previously installed sheet. Install presized jacket with an approximate overlap at butt joint of 2 inches over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.
3. Continuous jacket can be spiral wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.
4. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches or less. The 33-1/2-inch- circumference limit allows for 2-inch- overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
5. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

3.10 FINISHES

A. Equipment and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 painting Sections.

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

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

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.11 EQUIPMENT INSULATION SCHEDULE

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

B. Insulate indoor and outdoor equipment in paragraphs below that is not factory insulated.

C. Domestic hot-water pump insulation shall be the following:

1. Mineral-Fiber Board: 1 inch thick and 2-lb/cu. ft. nominal density.

D. Domestic water, domestic chilled-water (potable), and domestic hot-water hydropneumatic tank insulation shall be one of the following:

1. Mineral-Fiber Board: 1 inch thick and 2-lb/cu. ft. nominal density.
2. Mineral-Fiber Pipe and Tank: 1 inch thick.

3.12 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

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

3.13 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Cold Water:

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

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

2. NPS 2 and Larger: Insulation shall be the following:

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

B. Domestic Hot and Recirculated Hot Water:

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

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

2. NPS 2 and Larger: Insulation shall be the following:

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

C. Stormwater and Overflow:

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

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

D. Roof Drain and Overflow Drain Bodies:

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

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

E. 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.

3.14 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. Equipment, Concealed:

1. None.

D. Equipment, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches.

1. Aluminum, Stucco Embossed: 0.016 inch thick.

E. Equipment, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger Than 72 Inches:

1. Aluminum, Stucco Embossed with 1-1/4-Inch- Deep Corrugations: 0.032 inch thick.

F. Piping, Concealed:

1. None.

G. Piping, Exposed:

1. PVC: 20 mils thick.

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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. Under-building-slab and aboveground domestic water pipes, tubes, and fittings inside buildings.

B. Related Requirements:

1. Division 22 Section "Facility 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: For transition fittings and dielectric fittings.

B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.
2. Laboratory Test Reports for Credit IEQ 4: For solvent cements and adhesive primers, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Delegated-Design Submittal:

1. Design calculations and detailed fabrication and assembly of pipe anchors and alignment guides, hangers and supports for multiple pipes, expansion joints and loops, and attachments of the same to the building structure.
2. Locations of pipe anchors and alignment guides and expansion joints and loops.
3. Locations of and details for penetrations, including sleeves and sleeve seals for exterior walls, floors, basement, and foundation walls.

1.4 INFORMATIONAL SUBMITTALS

A. System purging and disinfecting activities report.

B. Field quality-control reports.

1.5 FIELD CONDITIONS

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

1. Notify Construction Manager or owner no fewer than two days in advance of proposed interruption of water service.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

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

B. Potable-water piping and components shall comply with NSF 14 and NSF 61. Plastic piping components shall be marked with "NSF-pw."

C. All piping shall be American made and tested; no import pipe will be permitted.

D. All exposed water supply piping in toilet rooms, custodial rooms and kitchens shall be chromium plated.

E. All piping installed in or passing through a plenum must be plenum rated, fire wrapped, or installed in a metal conduit.

2.2 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type K water tube, drawn temper.

B. Soft Copper Tube: ASTM B 88, Type K water tube, annealed temper.

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

D. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.

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

F. Copper Unions:

1. MSS SP-123.
2. Cast-copper-alloy, hexagonal-stock body.
3. Ball-and-socket, metal-to-metal seating surfaces.
4. Solder-joint or threaded ends.

2.3 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials:

1. AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
2. Full-face or ring type unless otherwise indicated.

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

C. Solder Filler Metals: ASTM B 32, lead-free alloys.

D. Flux: ASTM B 813, water flushable.

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

2.4 TRANSITION FITTINGS

A. General Requirements:

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

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

C. Sleeve-Type Transition Coupling: AWWA C219.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Cascade Waterworks Manufacturing.
b. Dresser, Inc.; Piping Specialties Products.
c. Ford Meter Box Company, Inc. (The).
d. JCM Industries.
e. Romac Industries, Inc.
f. Smith-Blair, Inc.; a Sensus company.
g. Viking Johnson.

D. Plastic-to-Metal Transition Fittings:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following

      a. Charlotte Pipe and Foundry Company.
      b. Harvel Plastics, Inc.
      c. Spears Manufacturing Company.

   2. Description:

      a. CPVC or PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions.
      b. One end with threaded brass insert and one solvent-cement-socket or threaded end.

E. Plastic-to-Metal Transition Unions:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

      a. Colonial Engineering, Inc.
      b. NIBCO Inc.
      c. Spears Manufacturing Company.

   2. Description:

      a. CPVC four-part union.
      b. Brass threaded end.
      c. Solvent-cement-joint plastic end.
      d. Rubber O-ring.
      e. Union nut.

2.5 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Nipples and Waterways:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

      a. Elster Perfection Corporation.
      b. Grinnell Mechanical Products; Tyco Fire Products LP.
      c. Matco-Norca.
      d. Clearflow/Perfection Corp.
      e. Precision Plumbing Products, Inc.
      f. Victaulic Company.

   2. Standard: IAPMO PS 66 or ASTM F-1545-97.

3. Electroplated steel nipple or waterway complying with ASTM F 1545 or ANSI/NSF-61 Compliant.
4. Pressure Rating and Temperature: 300 psig at 225 deg F.
5. End Connections: Male threaded or grooved.
6. Lining: Inert and noncorrosive, propylene or LTHS.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING INSTALLATION

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

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

C. Install underground copper tube in PE encasement according to ASTM A 674 or AWWA C105/A21.5.

D. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve inside the building at each domestic water-service entrance. Comply with requirements for pressure gages in Division 22 Section "Meters and Gages for Plumbing Piping" and with requirements for drain valves and strainers in Division 22 Section "Domestic Water Piping Specialties."

E. Install shutoff valve immediately upstream of each dielectric fitting.

F. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in Division 22 Section "Domestic Water Piping Specialties."

G. Install domestic water piping level with 0.25 percent slope downward toward drain and plumb.
   1. Piping will be drained seasonally for freeze protection.

H. Install seismic restraints on piping. Comply with SEI/ASCE 7 and with requirements for seismic-restraint devices in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

I. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

J. 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.

K. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

L. Install piping to permit valve servicing.

M. 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.

N. Install piping free of sags and bends.

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

P. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

Q. Install pressure gages on suction and discharge piping for each plumbing pump and packaged booster pump. Comply with requirements for pressure gages in Division 22 Section "Meters and Gages for Plumbing Piping."

R. Install thermostats in hot-water circulation piping. Comply with requirements for thermostats in Division 22 Section "Domestic Water Pumps."

S. Install thermometers on inlet piping from each water heater. Comply with requirements for thermometers in Division 22 Section "Meters and Gages for Plumbing Piping."

T. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."

U. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."

V. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22 Section "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

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

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

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.

E. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

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

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

3.4 TRANSITION FITTING INSTALLATION

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Underground Domestic Water Piping:

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

C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plastic-to-metal transition fittings.

3.5 DIELECTRIC FITTING INSTALLATION

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

B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric nipples/waterways.

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

D. Dielectric Fittings for NPS 5 and Larger: Use dielectric nipples/waterways.

3.6 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for seismic-restraint devices in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for pipe hanger, support products, and installation in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

1. Vertical Piping: MSS Type 8 or 42, clamps.
2. Individual, Straight, Horizontal Piping Runs:

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

3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.

E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
4. NPS 2-1/2: 108 inches with 1/2-inch rod.
5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
6. NPS 6: 10 feet with 5/8-inch rod.
7. NPS 8: 10 feet with 3/4-inch rod.

F. Install supports for vertical copper tubing every 10 feet.

G. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4 and Smaller: 84 inches with 3/8-inch rod.
2. NPS 1-1/2: 108 inches with 3/8-inch rod.
3. NPS 2: 10 feet with 3/8-inch rod.
4. NPS 2-1/2: 11 feet with 1/2-inch rod.
5. NPS 3 and NPS 3-1/2: 12 feet with 1/2-inch rod.
6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
7. NPS 6: 12 feet with 3/4-inch rod.
8. NPS 8 to NPS 12: 12 feet with 7/8-inch rod.

H. Install supports for vertical steel piping every 15 feet.

I. Install supports for vertical PP piping every 60 inches for NPS 1 and smaller, and every 72 inches for NPS 1-1/4 and larger.

J. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.7 CONNECTIONS

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

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

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

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
   1. 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. Comply with requirements for connection sizes in Division 22 plumbing fixture Sections.
   3. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.8 IDENTIFICATION

A. Identify system components. Comply with requirements for identification materials and installation in Division 22 Section "Identification for Plumbing Piping and Equipment."

B. Label pressure piping with system operating pressure.

3.9 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

   1. Piping Inspections:

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

b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:

1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.

c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

2. Piping Tests:

a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
d. Cap and subject piping to static water pressure of 50 psigabove operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
f. Prepare reports for tests and for corrective action required.

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

C. Prepare test and inspection reports.

3.10 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.

a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
b. Adjust calibrated balancing valves to flows indicated.

5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.11 CLEANING

A. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:

a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
b. Fill and isolate system according to either of the following:

1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.

c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
d. Repeat procedures if biological examination shows contamination.
e. Submit water samples in sterile bottles to authorities having jurisdiction.

B. Clean non-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 procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:

a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

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

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

3.12 PIPING SCHEDULE

A. Some piping types and sizes mentioned in this section may not be used on this project.

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

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

D. All exposed water supply piping in toilet rooms, custodial rooms and kitchens shall be chromium plated.

E. Under-building-slab, domestic water, building-service piping, NPS 3and smaller, shall be the following:

1. Soft copper tube, ASTM B 88, Type K wrought-copper, solder-joint fittings; and brazed joints.

F. Under-building-slab, domestic water, building-service piping, NPS 4 to NPS 8 and larger, shall be the following:

1. Soft copper tube, ASTM B 88, Type K; wrought-copper, solder-joint fittings; and brazed joints.

G. Under-building-slab, domestic water piping, NPS 2 and smaller , shall be the following:

1. Hard copper tube, ASTM B 88, Type K; wrought-copper, solder-joint fittings; and brazed joints.

H. Aboveground domestic water piping, NPS 2and smaller , shall be one of the following:
1. Hard copper tube, ASTM B 88, Type L cast- copper, solder-joint fittings; and soldered joints.

I. Aboveground domestic water piping, NPS 2-1/2 to NPS 4 , shall be one of the following:

1. Hard copper tube, ASTM B 88, Type L; cast- copper, solder-joint fittings; and soldered joints.

J. Aboveground domestic water piping, NPS 5 and larger shall be one of the following:

1. Hard copper tube, ASTM B 88, Type L; cast- copper, solder-joint fittings; and soldered joints.

3.13 VALVE SCHEDULE

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Shutoff Duty: Use ball for piping NPS 3 and smaller. Use butterfly, with flanged ends for piping NPS 4 and larger.
2. Throttling Duty: Use ball valves for piping NPS 2 and smaller. Use butterfly valves with flanged ends for piping NPS 2-1/2 and larger.
3. Hot-Water Circulation Piping, Balancing Duty: Calibrated balancing valves.
4. Drain Duty: Hose-end drain valves.

B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

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. This Section includes the following domestic water piping specialties:

1. Vacuum breakers.
2. Backflow preventers.
3. Water pressure-reducing valves.
4. Balancing valves.
5. Temperature-actuated water mixing valves.
6. Strainers.
7. Outlet boxes.
8. Hose bibbs.
9. Wall hydrants.
10. Drain valves.
11. Water hammer arresters.

B. Related Sections include the following:

1. Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers, pressure gages, and flow meters in domestic water piping.
2. Division 22 Section "Drinking Fountains and Water Coolers" for water filters for water coolers.

1.3 PERFORMANCE REQUIREMENTS

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

1.4 SUBMITTALS

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

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Field quality-control test reports.

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

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. NSF Compliance:

1. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components.
2. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."

PART 2 - PRODUCTS

2.1 VACUUM BREAKERS

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

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

a. Ames Co.
b. Cash Acme.
c. Conbraco Industries, Inc.
d. FEBCO; SPX Valves & Controls.
e. Rain Bird Corporation.
f. Toro Company (The); Irrigation Div.
g. Watts Industries, Inc.; Water Products Div.
h. Zurn Plumbing Products Group; Wilkins Div.

2. Standard: ASSE 1001.
3. Size: NPS 1/4 to NPS 3, as required to match connected piping.
4. Body: Bronze.
5. Inlet and Outlet Connections: Threaded.
6. Finish: Chrome plated.

B. Hose-Connection Vacuum Breakers:

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

a. Arrowhead Brass Products, Inc.
b. Cash Acme.
c. Conbraco Industries, Inc.
d. Legend Valve.
e. MIFAB, Inc.
f. Prier Products, Inc.
g. Watts Industries, Inc.; Water Products Div.
h. Woodford Manufacturing Company.
i. Zurn Plumbing Products Group; Light Commercial Operation.
j. Zurn Plumbing Products Group; Wilkins Div.

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, provide products by one of the following:

a. Ames Co.
b. Conbraco Industries, Inc.
c. FEBCO; SPX Valves & Controls.
d. Flomatic Corporation.
e. Toro Company (The); Irrigation Div.
f. Watts Industries, Inc.; Water Products Div.
g. Zurn Plumbing Products Group; Wilkins Div.

2. Standard: ASSE 1020.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 5 psig maximum, through middle 1/3 of flow range.
5. Accessories:

a. Valves: Ball type, on inlet and outlet.

D. Spill-Resistant Vacuum Breakers:

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

a. Conbraco Industries, Inc.
b. Watts Industries, Inc.; Water Products Div.

2. Standard: ASSE 1056.
3. Operation: Continuous-pressure applications.
4. Accessories:

a. Valves: Ball type, on inlet and outlet.

2.2 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers:

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

   a. Ames Co.
   b. Conbraco Industries, Inc.
   c. FEBCO; SPX Valves & Controls.
   d. Flomatic Corporation.
   e. Watts Industries, Inc.; Water Products Div.
   f. Zurn Plumbing Products Group; Wilkins Div.

2. Standard: ASSE 1013.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 12 psig maximum, through middle 1/3 of flow range.
5. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved] for NPS 2-1/2 and larger.
6. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
7. Accessories:

   a. Valves: Ball type with threaded ends on inlet and outlet ofNPS 2 and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of NPS 2-1/2 and larger.
   b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

B. Double-Check Backflow-Prevention Assemblies:

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

   a. Ames Co.
   b. Conbraco Industries, Inc.
   c. FEBCO; SPX Valves & Controls.
   d. Flomatic Corporation.
   e. Watts Industries, Inc.; Water Products Div.
   f. Zurn Plumbing Products Group; Wilkins Div.

2. Standard: ASSE 1015.
3. Operation: Continuous-pressure applications, unless otherwise indicated.
4. Pressure Loss: 5 psig maximum, through middle 1/3 of flow range.
5. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.

6. End Connections: Threaded for NPS 2 and smaller; [flanged] <Insert type> for NPS 2-1/2 and larger.
7. Accessories:

    a. Valves: Ball type with threaded ends on inlet and outlet ofNPS 2 and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of NPS 2-1/2 and larger.

C. Beverage-Dispensing-Equipment Backflow Preventers:

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

    a. Conbraco Industries, Inc.
    b. Watts Industries, Inc.; Water Products Div.
    c. Zurn Plumbing Products Group; Wilkins Div.

2. Standard: ASSE 1022.
3. Operation: Continuous-pressure applications.
4. Size: NPS 1/4 or NPS 3/8.
5. Body: Stainless steel.
6. End Connections: Threaded.

D. Dual-Check-Valve Backflow Preventers:

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

    a. Cash Acme.
    b. Conbraco Industries, Inc.
    c. FEBCO; SPX Valves & Controls.
    d. Flomatic Corporation.
    e. Ford Meter Box Company, Inc. (The).
    f. Honeywell Water Controls.
    g. Legend Valve.
    h. McDonald, A. Y. Mfg. Co.
    i. Mueller Co.; Water Products Div.
    j. Watts Industries, Inc.; Water Products Div.
    k. Zurn Plumbing Products Group; Wilkins Div.

2. Standard: ASSE 1024.
3. Operation: Continuous-pressure applications.
4. Body: Bronze with union inlet.

E. Carbonated-Beverage-Dispenser, Dual-Check-Valve Backflow Preventers:

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

a. Cash Acme.
b. Lancer Corporation.
c. Watts Industries, Inc.; Water Products Div.

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.

2.3 WATER PRESSURE-REDUCING VALVES

A. Water Control Valves: (Pilot type)

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

a. CLA-VAL Automatic Control Valves.
b. Mifab Corp; Beeco.
c. Watts Industries, Inc.; Ames Fluid Control Systems.
d. Watts Industries, Inc.; Watts ACV.
e. Zurn Plumbing Products Group; Wilkins Div.

2. Description: Pilot-operation, diaphragm-type, single-seated main water control valve.
3. Pressure Rating: Initial working pressure of 150 psig minimum with AWWA C550 or FDA-approved, interior epoxy coating. Include small pilot-control valve, restrictor device, specialty fittings, and sensor piping.
4. Main Valve Body: Cast- or ductile-iron body with AWWA C550 or FDA-approved, interior epoxy coating; or stainless-steel body.
5. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.

2.4 BALANCING VALVES

A. Copper-Alloy Calibrated Balancing Valves:

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

a. Armstrong International, Inc.
b. Flo Fab Inc.
c. ITT Industries; Bell & Gossett Div.
d. NIBCO INC.
e. TAC Americas.
f. Taco, Inc.
g. Victaulic
h. Watts Industries, Inc.; Water Products Div.

2. Type: Ball or Y-pattern globe valve with two readout ports and memory setting indicator.
3. Body: bronze,
4. Size: Same as connected piping, but not larger than NPS 2.
5. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

2.5 TEMPERATURE-ACTUATED WATER MIXING VALVES

A. Water-Temperature Limiting Devices:

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

   a. Armstrong International, Inc.
   b. Cash Acme.
   c. Conbraco Industries, Inc.
   d. Honeywell Water Controls.
   e. Legend Valve.
   f. Leonard Valve Company.
   g. Powers; a Watts Industries Co.
   h. Symmons Industries, Inc.
   i. Taco, Inc.
   j. Watts Industries, Inc.; Water Products Div.
   k. Zurn Plumbing Products Group; Wilkins Div.

2. Standard: ASSE 1017.
3. Pressure Rating: 125 psig.
4. Type: Thermostatically controlled water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: Threaded union inlets and outlet.
7. Accessories: Check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
8. Valve Finish: Rough bronze.

B. Primary, Thermostatic, Water Mixing Valves:

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

   a. Armstrong International, Inc.
   b. Lawler Manufacturing Company, Inc.
   c. Leonard Valve Company.
   d. Powers; a Watts Industries Co.
   e. Symmons Industries, Inc.

2. Standard: ASSE 1017.
3. Pressure Rating: 125 psig.

4. Type: Exposed-mounting, thermostatically controlled water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: Threaded union inlets and outlet.
7. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
8. Valve Pressure Rating: 125 psig minimum, unless otherwise indicated.
9. Valve Finish: Chrome plated.
10. Piping Finish: Copper.

C. Individual-Fixture, Water Tempering Valves:

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

   a. Cash Acme.
   b. Conbraco Industries, Inc.
   c. Honeywell Water Controls.
   d. Lawler Manufacturing Company, Inc.
   e. Leonard Valve Company.
   f. Powers; a Watts Industries Co.
   g. Watts Industries, Inc.; Water Products Div.
   h. Zurn Plumbing Products Group; Wilkins Div.

2. Standard: ASSE 1070, thermostatically controlled water tempering valve.
3. Pressure Rating: 125 psig minimum, unless otherwise indicated.
4. Body: Bronze body with corrosion-resistant interior components.
5. Temperature Control: Adjustable.
6. Inlets and Outlet: Threaded.
7. Finish: Rough or chrome-plated bronze.

2.6 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Pressure Rating: 125 psig minimum, unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or FDA-approved, epoxy coating and for NPS 2-1/2 and larger.
3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
4. Screen: Stainless steel with round perforations, unless otherwise indicated.
5. Perforation Size:

   a. Strainers NPS 2 and Smaller: 0.020 inch.
   b. Strainers NPS 2-1/2 to NPS 4: 0.045 inch.
   c. Strainers NPS 5 and Larger: 0.10 inch.

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

2.7 OUTLET BOXES

A. Icemaker Outlet Boxes ICE-1:

1. Basis of Design: Guy Gray model FR1212SHACP fire rated washing machine box with one ¼ turn valve with water hammer arrestor and 1-1/2" drain connection.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Acorn Engineering Company.
    b. Guy Gray Manufacturing Co., Inc.
    c. IPS Corporation.
    d. LSP Products Group, Inc.
    e. Oatey.
    f. Plastic Oddities; a division of Diverse Corporate Technologies.
    g. Symmons Industries, Inc.
    h. Watts Industries, Inc.; Water Products Div.
    i. Whitehall Manufacturing; a div. of Acorn Engineering Company.
    j. Zurn Plumbing Products Group; Light Commercial Operation.

3. Mounting: Recessed.
4. Material and Finish: Enameled-steel or epoxy-painted-steel or plastic box and faceplate.
5. Faucet: Combination, valved fitting or separate hot- and cold-water, valved fittings complying with ASME A112.18.1. Include garden-hose thread complying with ASME B1.20.7 on outlets.
6. Supply Shutoff Fittings: NPS 1/2 gate, globe, or ball valves and NPS 1/2 copper, water tubing.
7. Drain: [NPS 1-1/2] [NPS 2] standpipe and P-trap for direct waste connection to drainage piping.
8. Inlet Hoses: Two 60-inch- long, rubber household clothes washer inlet hoses with female, garden-hose-thread couplings. Include rubber washers.
9. Drain Hose: One 48-inch- long, rubber household clothes washer drain hose with hooked end.

B. Water Outlet Boxes W-1:

1. Basis of Design: Water-Tite model W9200HA 6" diameter outlet box with ¼ turn valve and water hammer arrestor.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Acorn Engineering Company.
    b. IPS Corporation.
    c. LSP Products Group, Inc.
    d. Oatey.
    e. Plastic Oddities; a division of Diverse Corporate Technologies.

3. Mounting: Recessed.

4. Material and Finish: Enameled-steel or epoxy-painted-steel or plastic box and faceplate.
5. Faucet: Valved fitting complying with ASME A112.18.1. Include NPS 1/2 or smaller copper tube outlet.
6. Supply Shutoff Fitting: NPS 1/2 gate, globe, or ball valve and NPS 1/2 copper, water tubing.

2.8 HOSE BIBBS

A. Hose Bibbs HB-1:

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

2.9 WALL HYDRANTS

A. Nonfreeze Wall Hydrants FWH-1:

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

    a. Josam Company.
    b. MIFAB, Inc.
    c. Prier Products, Inc.
    d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
    e. Tyler Pipe; Wade Div.
    f. Watts Drainage Products Inc.
    g. Woodford Manufacturing Company.
    h. Zurn Plumbing Products Group; Light Commercial Operation.
    i. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.21.3M for concealed-outlet, self-draining wall hydrants.
3. Pressure Rating: 125 psig.

4. Operation: Loose key.
5. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
6. Inlet: NPS 3/4 or NPS 1.
7. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
8. Box: Deep, flush mounting with cover.
9. Box and Cover Finish: Polished nickel bronze.
10. Operating Keys: Two with each wall hydrant.

2.10 DRAIN VALVES

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

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

2.11 WATER HAMMER ARRESTERS

A. Water Hammer Arresters:

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

   a. AMTROL, Inc.
   b. Josam Company.
   c. MIFAB, Inc.
   d. PPP Inc.
   e. Sioux Chief Manufacturing Company, Inc.
   f. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   g. Tyler Pipe; Wade Div.
   h. Watts Drainage Products Inc.
   i. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASSE 1010 or PDI-WH 201.
3. Type: Metal bellows or Copper tube with piston.
4. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.

B. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.

1. Locate backflow preventers in same room as connected equipment or system.
2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
3. Do not install bypass piping around backflow preventers.

C. Install water control valves with inlet and outlet shutoff valves. Install pressure gages on inlet and outlet.

D. Install balancing valves in locations where they can easily be adjusted.

E. Install temperature-actuated water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.

1. Install thermometers and water regulators if specified.
2. Install cabinet-type units recessed in or surface mounted on wall as specified.

F. Install Y-pattern strainers for water on supply side of each control valve, water pressure-reducing valve, solenoid valve, and pump.

G. Install outlet boxes recessed in wall. Install 2-by-4-inch fire-retardant-treated-wood blocking wall reinforcement between studs. Fire-retardant-treated-wood blocking is specified in Division 06 Section "Rough Carpentry."

H. Install water hammer arresters in water piping according to PDI-WH 201.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping and specialties.

B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

C. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 LABELING AND IDENTIFYING

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

1. Pressure vacuum breakers.
2. Reduced-pressure-principle backflow preventers.
3. Double-check backflow-prevention assemblies.
4. Carbonated-beverage-machine backflow preventers.
5. Dual-check-valve backflow preventers.
6. Water pressure-reducing valves.
7. Calibrated balancing valves.
8. Primary, thermostatic, water mixing valves.
9. Primary water tempering valves.
10. Outlet boxes.

B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and prepare test reports:

1. Test each backflow preventer according to authorities having jurisdiction and the device's reference standard.

B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

3.5 ADJUSTING

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

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

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

END OF SECTION 221119

SECTION 221123 - 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. This Section includes the following all-bronze and bronze-fitted centrifugal pumps for domestic cold- and hot-water circulation:

1. Separately-coupled, horizontally mounted, in-line centrifugal pumps.

1.3 SEISMIC REQUIREMENTS

A. Component Importance Factor. All plumbing components shall be assigned a component importance factor. The component importance factor, I*p*, shall be taken as 1.5 if any of the following conditions apply:

1. The component is required to function for life-safety purposes after an earthquake.
2. The component contains hazardous materials.
3. The component is in or attached to an Occupancy Category IV structure and it is needed for continued operation of the facility or its failure could impair the continued operation of the facility.

B. All other components shall be assigned a component importance factor, I*p*, equal to 1.0.

C. Seismic Performance: Plumbing equipment, hangers and supports shall withstand the effects of earthquake motions determined according to SEI/ASCE 7 and with the requirements specified in Section 220548 " Vibration and Seismic Controls for Plumbing Piping and Equipment.

1. For components with a seismic importance factor of 1.0 the term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified."

2. For components with a seismic importance factor of 1.5 the term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified and the system will be fully operational after the seismic event."

1.4 SUBMITTALS

A. Product Data: For each type and size of domestic water pump specified. Include certified performance curves with operating points plotted on curves; and rated capacities of selected models, furnished specialties, and accessories.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Operation and Maintenance Data: For domestic water pumps to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of domestic water pumps 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. UL Compliance: Comply with UL 778 for motor-operated water pumps.

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 rigging instructions for handling.

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

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

2.2 SEPARATELY COUPLED, HORIZONTALLY MOUNTED, IN-LINE CENTRIFUGAL PUMPS

A. Manufacturers:

1. Armstrong.
2. Aurora Pump; Pentair Pump Group (The).
3. Bell & Gossett Domestic Pump; ITT Industries.
4. Grundfos Pumps Corp.
5. Taco, Inc.
6. Thrush Company, Inc.
7. Weinman Div.; Crane Pumps & Systems.

B. Description: Factory-assembled and -tested, overhung-impeller, single-stage, separately coupled, horizontally mounted, in-line centrifugal pumps as defined in HI 1.1-1.2 and HI 1.3; and designed for installation with pump and motor shafts mounted horizontally.

1. Pump Construction: All bronze.

   a. Casing: Radially split, cast iron, with threaded companion-flange connections for pumps with NPS 2 pipe connections and flanged connections for pumps with NPS 2-1/2 pipe connections.
   b. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, closed, and keyed to shaft.
   c. Shaft and Shaft Sleeve: Steel shaft, with copper-alloy shaft sleeve.
   d. Seal: Mechanical, with carbon-steel rotating ring, stainless-steel spring, ceramic seat, and rubber bellows and gasket. Include water slinger on shaft between motor and seal.
   e. Bearings: Oil-lubricated; bronze-journal or ball type.

2. Shaft Coupling: Flexible, capable of absorbing torsional vibration and shaft misalignment.
3. Motor: Single speed, with grease-lubricated ball bearings; and resiliently mounted to pump casing. Comply with requirements in Division 22 Section "Common Motor Requirements for Plumbing Equipment."

2.3 FLEXIBLE CONNECTORS

A. Manufacturers:

1. Anamet, Inc.
2. Flex-Hose Co., Inc.
3. Flexicraft Industries.

4. Flex-Pression, Ltd.
5. Flex-Weld, Inc.
6. Fugate
7. Hyspan Precision Products, Inc.
8. Mercer Rubber.
9. Metraflex, Inc.
10. Proco Products, Inc.
11. Tozen America Corporation.
12. Twin City Hose.
13. Unaflex Inc.

B. Description: Corrugated, bronze inner tubing covered with bronze wire braid. Include copper-tube ends or bronze flanged ends, braze-welded to tubing. Include 125-psig minimum working-pressure rating and ends matching pump connections.

2.4 BUILDING-AUTOMATION-SYSTEM INTERFACE

A. Provide auxiliary contacts in pump controllers for interface to building automation system. Include the following:

1. On-off status of each pump.
2. Alarm status.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PUMP INSTALLATION

A. Comply with SEI/ASCE 7 and with requirements for seismic-restraint devices in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with HI 1.4.

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

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

E. Install separately coupled, horizontally mounted, in-line centrifugal pumps with motor and pump shafts horizontal.

F. Install continuous-thread hanger rods and spring hangers with vertical-limit stop of sufficient size to support pump weight. Vibration isolation devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment." Fabricate brackets or supports as required. Hanger and support materials are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

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

C. Connect domestic water piping to pumps. Install suction and discharge piping equal to or greater than size of pump nozzles. Refer to Division 22 Section "Domestic Water Piping."

1. Install flexible connectors adjacent to pumps in suction and discharge piping of the following pumps:

   a. Separately coupled, horizontally mounted, in-line centrifugal pumps.

2. Install shutoff valve and strainer on suction side of pumps, and check valve and throttling valve on discharge side of pumps. Install valves same size as connected piping. Refer to Division 22 Section "General-Duty Valves for Plumbing Piping" for general-duty valves for domestic water piping and Division 22 Section "Domestic Water Piping Specialties" for strainers.
3. Install pressure gages at suction and discharge of pumps. Install at integral pressure-gage tappings where provided or install pressure-gage connectors in suction and discharge piping around pumps. Refer to Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages and gage connectors.

D. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

E. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

F. Interlock pump with water heater burner and time delay relay.

3.4 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. 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.
8. Adjust temperature settings on thermostats.
9. Adjust timer settings.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain pumps. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 221123

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. Pipe, tube, and fittings.
2. Specialty pipe fittings.

1.3 PERFORMANCE REQUIREMENTS

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

1. Soil, Waste, and Vent Piping: 10-foot head of water.

1.4 ACTION SUBMITTALS

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

B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.
2. Laboratory Test Reports for Credit IEQ 4: For solvent cements and adhesive primers, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

1.5 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For waste and vent piping, 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. Detailed description of piping anchorage devices on which the certification is based and their installation requirements.

B. Field quality-control reports.

1.6 QUALITY ASSURANCE

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

B. Comply with NSF/ANSI 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping; "NSF-sewer" for plastic sewer piping; "NSF-drain" for plastic drain piping, and "NSF-tubular" for plastic continuous waste piping.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

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

2.2 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: All cast-iron waste, vent and sewer pipe and fittings shall conform to the requirements of CISPI Standard 301 and ASTM A 888. All products shall be marked with the collective trademark of the Cast Soil Pipe Institute and shall be listed by NSF International or receive prior approval of the engineer. All cast-iron pipe and fittings shall be American made and tested. Non-compliant import cast-iron products will not be permitted. Any non-compliant cast-iron product installed by the contractor on this project will be replaced at the contractor’s expense and shall include all repairs, patching, painting and other incidental work required to return the project to its pre-remediation state.

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

a. AB&I Foundry
b. Charoltte Pipe
c. Tyler Pipe

B. CISPI, Hubless-Piping Couplings:

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

   a. ANACO.
   b. Ideal
   c. Mission Rubber Company; a division of MCP Industries, Inc.
   d. Tyler Pipe.

2. Standards: ASTM C 1277 and CISPI 310.
3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.
4. Listing: Couplings shall be listed by NSF International. Each coupling shall be embossed with the NSF seal.

2.3 PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

B. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

C. Adhesive Primer: ASTM F 656.

1. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Adhesive primer shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. Solvent Cement: ASTM D 2564.

1. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Solvent cement shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.4 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

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

3. Unshielded, Nonpressure Transition Couplings:

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

      1) Dallas Specialty & Mfg. Co.
      2) Fernco Inc.
      3) Logan Clay Products Company
      4) Mission Rubber Company; a division of MCP Industries, Inc.

   b. Standard: ASTM C 1173.
   c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
   d. Sleeve Materials:

      1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
      2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
      3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

4. Shielded, Nonpressure Transition Couplings:

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

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

   b. Standard: ASTM C 1460.
   c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

5. Pressure Transition Couplings:

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

      1) Cascade Waterworks Mfg. Co.
      2) Dresser, Inc.
      3) EBAA Iron, Inc.
      4) JCM Industries, Inc.
      5) Romac Industries, Inc.
      6) Smith-Blair, Inc.; a Sensus company.
      7) The Ford Meter Box Company, Inc.
      8) Viking Johnson.

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.

PART 3 - EXECUTION

3.1 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Division 31 Section "Earth Moving."

3.2 PIPING INSTALLATION

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

B. Install 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. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not

change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

K. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

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

1. Building Sanitary Drain: 2 percent downward in direction of flow for piping.
2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

M. Install underground PVC piping according to ASTM D 2321.

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

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

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

1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.

P. Plumbing Specialties:
1. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping. Comply with requirements for cleanouts specified in Division 22 Section "Sanitary Waste Piping Specialties."
2. Install drains in sanitary drainage gravity-flow piping. Comply with requirements for drains specified in Division 22 Section "Sanitary Waste Piping Specialties."
3. Install cleanout fitting with closure plug inside the building in sanitary force-main piping.

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

R. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."

S. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."

T. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22 Section "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

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

B. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
3. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

3.4 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in OD's.
2. In Drainage Piping Shielded, nonpressure transition couplings.

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

3.5 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger and support devices and installation specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

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

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

7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.

8. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support horizontal piping and tubing within 12 inches of each fitting and coupling.

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.

E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
2. NPS 3: 60 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 60 inches with 5/8-inchod.
4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
5. NPS 10 and NPS 12: 60 inches with 7/8-inch rod.
6. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

F. Install supports for vertical cast-iron soil piping every 15 feet.

G. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

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 drainage and vent piping to the following:

1. Plumbing Fixtures: Connect drainage 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 drainage 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 Division 22 Section "Sanitary Waste Piping Specialties."
6. Equipment: Connect drainage piping as indicated. Provide shutoff valve if indicated and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.

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

E. Make fixture and equipment connections according to the following unless otherwise indicated:

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

3.7 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Division 22 Section "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 drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-

stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.

5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

3.9 CLEANING AND PROTECTION

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

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

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

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

C. Aboveground, soil and waste piping NPS 4 and larger shall be the following:
1. Hubless, cast-iron soil pipe and fittings heavy-duty hubless-piping couplings; and coupled joints.
2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

D. Aboveground, vent piping NPS 3 and smaller shall be the following:
1. Hubless, cast-iron soil pipe and fittings CISPI hubless-piping couplings; and coupled joints.
2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

E. Aboveground, vent piping NPS 4 and larger shall be the following:
1. Hubless, cast-iron soil pipe and fittings CISPI hubless-piping couplings; and coupled joints.
2. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.

F. Underground, soil, waste, and vent piping NPS 3 and smaller shall be the following:
1. Hubless, cast-iron soil pipe and fittings CISPI hubless-piping couplings; and coupled joints.
2. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

3. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

G. Underground, soil and waste piping NPS 4 and larger shall be the following:
1. Hubless, cast-iron soil pipe and fittings heavy-duty hubless-piping couplings; and coupled joints.
2. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
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. This Section includes the following sanitary drainage piping specialties:

1. Cleanouts.
2. Floor drains.
3. Roof flashing assemblies.
4. Through-penetration firestop assemblies.
5. Miscellaneous sanitary drainage piping specialties.
6. Flashing materials.
7. Grease removal devices.

B. Related Sections include the following:

1. Division 22 Section "Storm Drainage Piping Specialties" for trench drains for storm water, channel drainage systems for storm water, roof drains, and catch basins.

1.3 SEISMIC REQUIREMENTS

A. Component Importance Factor. All plumbing components shall be assigned a component importance factor. The component importance factor, I*p*, shall be taken as 1.5 if any of the following conditions apply:

1. The component is required to function for life-safety purposes after an earthquake.
2. The component contains hazardous materials.
3. The component is in or attached to an Occupancy Category IV structure and it is needed for continued operation of the facility or its failure could impair the continued operation of the facility.

B. All other components shall be assigned a component importance factor, I*p*, equal to 1.0.

C. Seismic Performance: Plumbing equipment, hangers and supports shall withstand the effects of earthquake motions determined according to SEI/ASCE 7 and with the requirements specified in Section 220548 " Vibration and Seismic Controls for Plumbing Piping and Equipment.

1.4 DEFINITIONS

A. FOG: Fats, oils, and greases.

B. FRP: Fiberglass-reinforced plastic.

C. HDPE: High-density polyethylene plastic.

D. PE: Polyethylene plastic.

E. PP: Polypropylene plastic.

F. PVC: Polyvinyl chloride plastic.

1.5 SUBMITTALS

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

B. Field quality-control test reports.

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

1.6 QUALITY ASSURANCE

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

B. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic sanitary piping specialty components.

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.

B. Coordinate size and location of roof penetrations.

PART 2 - PRODUCTS

2.1 CLEANOUTS

A. Exposed Metal Cleanouts:

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

a. Josam Company; Josam Div.
b. MIFAB, Inc.
c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
d. Tyler Pipe; Wade Div.
e. Watts Drainage Products Inc.
f. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
3. Size: Same as connected drainage piping
4. Body Material: Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk, brass plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Closure: Stainless-steel plug with seal.

B. Metal Floor Cleanouts:

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

a. Josam Company; Josam Div.
b. Oatey.
c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
d. Tyler Pipe; Wade Div.
e. Watts Drainage Products Inc.
f. Zurn Plumbing Products Group; Light Commercial Operation.
g. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M for adjustable housing cleanout.
3. Size: Same as connected branch.
4. Type: Adjustable housing.
5. Body or Ferrule: Cast iron.
6. Clamping Device: Required.
7. Outlet Connection: Inside calk.
8. Closure: Brass plug with tapered threads.
9. Adjustable Housing Material: Cast iron with threads.
10. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
11. Frame and Cover Shape: Round.
12. Top Loading Classification: Heavy Duty.
13. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.
14. Standard: ASME A112.3.1.
15. Size: Same as connected branch.
16. Housing: Stainless steel.
17. Closure: Stainless steel with seal.
18. Riser: Stainless-steel drainage pipe fitting to cleanout.

C. Cast-Iron Wall Cleanouts:

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

a. Josam Company; Josam Div.

b. MIFAB, Inc.
c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
d. Tyler Pipe; Wade Div.
e. Watts Drainage Products Inc.
f. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: Hub-and-spigot, cast-iron soil pipe T-branch as required to match connected piping.
5. Closure: Countersunk, brass plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.
8. Wall Access: Round, stainless-steel wall-installation frame and cover.

2.2 FLOOR DRAINS

A. Cast-Iron Floor Drains:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Basis-of-Design Product: See Schedule at end of this Section:

a. Josam Company; Josam Div.
b. MIFAB, Inc.
c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
d. Tyler Pipe; Wade Div.
e. Watts Drainage Products Inc.
f. Zurn Plumbing Products Group; Specification Drainage Operation.

3. Standard: ASME A112.6.3.
4. Body Material: Gray iron.
5. Seepage Flange: Required.
6. Anchor Flange: Not required.
7. Outlet: Bottom.
8. Trap Material: Cast iron>.
9. Trap Pattern: Deep-seal P-trap>.
10. Trap Features: Trap-seal primer valve drain connection>.

2.3 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Firestop Assemblies:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ProSet Systems Inc.

3. Standard: UL 1479 assembly of sleeve and stack fitting with firestopping plug.
4. Size: Same as connected soil, waste, or vent stack.
5. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
6. Stack Fitting: ASTM A 48/A 48M, gray-iron, hubless-pattern, wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.
7. Special Coating: Corrosion resistant on interior of fittings.

2.4 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Deep-Seal Traps:

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

   a. NPS 2: 4-inch- minimum water seal.
   b. NPS 2-1/2 and Larger: 5-inch- minimum water seal.

B. 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.

C. Sleeve Flashing Device:

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

D. 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.

E. Vent Cap Filters:

1. Description: Activated carbon filter in housing for installation at vent terminal as manufactured by Sweet Filter.
2. Size: Same as connected stack vent or vent stack.

2.5 FLASHING MATERIALS

A. Lead Sheet: ASTM B 749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:

1. General Use: 4.0-lb/sq. ft., 0.0625-inch thickness.
2. Vent Pipe Flashing: 3.0-lb/sq. ft., 0.0469-inch thickness.
3. Burning: 6-lb/sq. ft., 0.0938-inch thickness.

B. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.

C. Fasteners: Metal compatible with material and substrate being fastened.

D. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

E. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

PART 3 - EXECUTION

3.1 INSTALLATION

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

B. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.

C. Install backwater valves in building drain piping. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.

D. 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.

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

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

G. 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. Set with grates depressed according to the following drainage area radii:

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

3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

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

I. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

J. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

K. Install vent cap filters on each vent pipe passing through roof.

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

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

N. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

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

3.3 FLASHING INSTALLATION

A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:

1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft., 0.0938-inch thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft., 0.0625-inch thickness or thinner.

B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.

C. Set flashing on floors and roofs in solid coating of bituminous cement.

D. Secure flashing into sleeve and specialty clamping ring or device.

E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Division 07 Section "Sheet Metal Flashing and Trim."

F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

G. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled grease removal devices and their installation, including piping and electrical connections, and to assist in testing.

B. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.5 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.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain grease removal devices. Refer to Division 01 Section "Demonstration and Training."

3.7 FLOOR DRAIN SCHEDULE

See schedule on drawings

END OF SECTION 221319

SECTION 221413 - FACILITY 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. This Section includes the following storm drainage piping inside the building:

1. Pipe, tube, and fittings.
2. Special pipe fittings.

B. Related Sections include the following:

1. Division 22 Section "Sump Pumps."

1.3 SEISMIC REQUIREMENTS

A. Component Importance Factor. All plumbing components shall be assigned a component importance factor. The component importance factor, I*p*, shall be taken as 1.5 if any of the following conditions apply:

1. The component is required to function for life-safety purposes after an earthquake.
2. The component contains hazardous materials.
3. The component is in or attached to an Occupancy Category IV structure and it is needed for continued operation of the facility or its failure could impair the continued operation of the facility.

B. All other components shall be assigned a component importance factor, I*p*, equal to 1.0.

1.4 DEFINITIONS

A. LLDPE: Linear, low-density polyethylene plastic.

B. PE: Polyethylene plastic.

C. PVC: Polyvinyl chloride plastic.

D. TPE: Thermoplastic elastomer.

1.5 PERFORMANCE REQUIREMENTS

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

1. Storm Drainage Piping: 10-foot head of water.

B. Seismic Performance: Plumbing equipment, hangers and supports shall withstand the effects of earthquake motions determined according to SEI/ASCE 7 and with the requirements specified in Section 220548 " Vibration and Seismic Controls for Plumbing Piping and Equipment.

1. For components with a seismic importance factor of 1.0 the term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified."

2. For components with a seismic importance factor of 1.5 the term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified and the system will be fully operational after the seismic event."

1.6 SUBMITTALS

A. Product Data: For pipe, tube, fittings, and couplings.

B. Shop Drawings:

1. Design Calculations: Signed and sealed by a qualified professional engineer for selecting seismic restraints.
2. Controlled-Flow Storm Drainage System: Include calculations, plans, and details.

C. Field quality-control inspection and test reports.

D. Delegated-Design Submittal:

1. Design calculations and detailed fabrication and assembly of pipe anchors and alignment guides, hangers and supports for multiple pipes, expansion joints and loops, and attachments of the same to the building structure.
2. Locations of pipe anchors and alignment guides and expansion joints and loops.
3. Locations of and details for penetrations, including sleeves and sleeve seals for exterior walls, floors, basement, and foundation walls.
4. Seismic calculations and detailed analysis: Indicate fabrication and arrangement. Detail attachments of restraints to the 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. Project specific design documentation and calculations shall be prepared and stamped by a registered professional engineer who is responsible for the seismic restraint design and who is licensed in the state where the project is being constructed (ASCE 7, 13.2.1.1).

1.7 QUALITY ASSURANCE

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

B. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic drain piping and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

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

2.2 PIPING MATERIALS

A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.3 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301. All waste, vent, sewer and storm lines shall be soil pipe and fittings that conform to the requirements of CISPI Standard 301, ASTM A ** and shall be marked with the collective trademark of the Cast Soil Pipe Institute or Receive Prior approval of the engineer and manufactured by AB&I Foundry, Tyler Pipe, or Charlotte Pipe. In addition all Cast iron shall be American made and tested, no “non compliant” import cast iron will be permitted.

A. CISPI, Hubless-Piping Couplings:

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

a. ANACO.
b. Ideal
c. Mission Rubber Company; a division of MCP Industries, Inc.
d. Tyler Pipe.

2. Standards: ASTM C 1277 and CISPI 310.

3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.
4. Listing: Couplings shall be listed by NSF International. Each coupling shall be embossed with the NSF seal.

2.4 PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

2.5 SPECIAL PIPE FITTINGS

A. Flexible, Nonpressure Pipe Couplings: Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition pattern. Include shear ring, ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.

1. Manufacturers:

a. Dallas Specialty & Mfg. Co.
b. Fernco, Inc.
c. Logan Clay Products Company (The).
d. Mission Rubber Co.
e. NDS, Inc.
f. Plastic Oddities, Inc.

2. Sleeve Materials:

a. For Cast-Iron Soil Pipes: ASTM C 564, rubber.
b. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
c. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

B. Shielded Nonpressure Pipe Couplings: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

1. Manufacturers:

a. Cascade Waterworks Mfg. Co.
b. Mission Rubber Co.

PART 3 - EXECUTION

3.1 EXCAVATION

A. Refer to Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

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

B. Aboveground storm drainage piping shall be the following:

1. Hubless cast-iron soil pipe and fittings; heavy-duty shielded, stainless-steel couplings; and coupled joints.

C. Underground storm drainage piping shall be the following (to 6” above finished floor):

1. Hubless cast-iron soil pipe and fittings; heavy-duty shielded, stainless-steel couplings; and coupled joints.

2. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

3.3 PIPING INSTALLATION

A. Storm sewer and drainage piping outside the building are specified in Division 33 Section "Storm Utility Drainage Piping."

B. Comply with SEI/ASCE 7 and with requirements for seismic-restraint devices in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

C. Basic piping installation requirements are specified in Division 22 Section "Common Work Results for Plumbing."

D. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers. Cleanouts are specified in Division 22 Section "Storm Drainage Piping Specialties."

E. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping.

F. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Division 22 Section "Common Work Results for Fire Plumbing."

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

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

H. Make changes in direction for storm drainage piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

I. Lay buried building storm drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

J. Install storm drainage piping at the following minimum slopes, unless otherwise indicated:

1. Building Storm Drain: 1 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
2. Horizontal Storm-Drainage Piping: 1 percent downward in direction of flow.

K. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.

L. Install underground PVC storm drainage piping according to ASTM D 2321.

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

3.4 JOINT CONSTRUCTION

A. Basic piping joint construction requirements are specified in Division 22 Section "Common Work Results Plumbing."

B. Hubless Cast-Iron Soil Piping Coupled Joints: Join according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.

C. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.

3.5 HANGER AND SUPPORT INSTALLATION

A. Seismic-restraint devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Pipe hangers and supports are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment." Install the following:

1. Vertical Piping: MSS Type 8 or Type 42, clamps.

2. Individual, Straight, Horizontal Piping Runs: According to the following:

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

3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Install supports according to Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

D. Support vertical piping and tubing at base and at each floor.

E. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.

F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
2. NPS 3: 60 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
4. NPS 6: 60 inches with 3/4-inch rod.
5. NPS 8 to NPS 12: 60 inches with 7/8-inch rod.
6. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

G. Install supports for vertical cast-iron soil piping every 15 feet.

H. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.6 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.

3.7 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
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 according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

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

3.8 CLEANING

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

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

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

END OF SECTION 221413

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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. This Section includes the following storm drainage piping specialties:

1. Cleanouts.
2. Roof drains.
3. Miscellaneous storm drainage piping specialties.
4. Flashing materials.

B. Related Sections include the following:

1. Division 22 Section "Sanitary Waste Piping Specialties" for backwater valves, floor drains, trench drains and channel drainage systems connected to sanitary sewer, air admittance valves, FOG disposal systems, grease interceptors and removal devices, oil interceptors, and solid interceptors.

1.3 DEFINITIONS

A. PUR: Polyurethane plastic.

B. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS

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

1.5 QUALITY ASSURANCE

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

1.6 COORDINATION

A. Coordinate size and location of roof penetrations.

PART 2 - PRODUCTS

2.1 CLEANOUTS

A. Exposed Metal Cleanouts:

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

   a. Josam Company; Josam Div.
   b. MIFAB, Inc.
   c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   d. Sioux Chief Manufacturing Company, Inc
   e. Tyler Pipe; Wade Div.
   f. Watts Drainage Products Inc.
   g. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
3. Size: Same as connected drainage piping
4. Body Material: Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk, brass plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Closure: Stainless-steel plug with seal.

B. Metal Floor Cleanouts:

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

   a. Josam Company; Josam Div.
   b. Oatey.
   c. Sioux Chief Manufacturing Company, Inc.
   d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   e. Tyler Pipe; Wade Div.
   f. Watts Drainage Products Inc.
   g. Zurn Plumbing Products Group; Light Commercial Operation.
   h. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M for adjustable housing cleanout.
3. Size: Same as connected branch.
4. Type: Adjustable housing.

5. Body or Ferrule: Cast iron.
6. Clamping Device: Required.
7. Outlet Connection: Inside calk.
8. Closure: [Brass plug with tapered threads.
9. Adjustable Housing Material: Cast iron with threads.
10. Frame and Cover Material and Finish: Stainless steel.
11. Frame and Cover Shape: Round.
12. Top Loading Classification: Heavy Duty.
13. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.
14. Standard: ASME A112.3.1.
15. Size: Same as connected branch.
16. Housing: Stainless steel.
17. Closure: Stainless steel with seal.
18. Riser: Stainless-steel drainage pipe fitting to cleanout.

C. Cast-Iron Wall Cleanouts:

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

   a. Josam Company; Josam Div.
   b. MIFAB, Inc.
   c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   d. Sioux Chief Manufacturing Company, Inc
   e. Tyler Pipe; Wade Div.
   f. Watts Drainage Products Inc.
   g. Zurn Plumbing Products Group; Specification Drainage Operation.

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: Countersunk, brass plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.

2.2 ROOF DRAINS

A. Metal Roof Drains:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Basis-of-Design Product: See Schedule at end of this section for drain descriptions:

   a. Josam Company; Josam Div.
   b. MIFAB, Inc.
   c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   d. Sioux Chief Manufacturing Company, Inc

e. Tyler Pipe; Wade Div.
f. Watts Drainage Products Inc.
g. Zurn Plumbing Products Group; Specification Drainage Operation.

3. Standard: ASME A112.21.2M.
4. Body Material Cast iron.
5. Combination Flashing Ring and Gravel Stop: Required.
6. Dome Material: Cast iron.
7. Extension Collars: Required.
8. Underdeck Clamp Required.
9. Sump Receiver: Required.

B. Conductor Nozzles DSN-1:

1. Description: Bronze body with threaded inlet and bronze wall flange with mounting holes.
2. Size: Same as connected conductor.

2.3 FLASHING MATERIALS

A. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.

B. Fasteners: Metal compatible with material and substrate being fastened.

C. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

D. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.

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

1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 45 degrees.
3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.

4. Locate at base of each vertical soil and waste stack.

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

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

E. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions. Roofing materials are specified in Division 07.

1. Install roof-drain flashing collar or flange so that there will be no leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
2. Position roof drains for easy access and maintenance.

F. Install manufactured, gray-iron downspout boots at grade with top [6 inches] [12 inches] [18 inches] above grade. Secure to building wall.

G. Install conductor nozzles at exposed bottom of conductors where they spill onto grade.

H. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

3.3 FLASHING INSTALLATION

A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:

1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft., 0.0938-inch thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft., 0.0625-inch thickness or thinner.

B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.

C. Set flashing on floors and roofs in solid coating of bituminous cement.

D. Secure flashing into sleeve and specialty clamping ring or device.

E. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 PROTECTION

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

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

3.5 ROOF DRAIN SCHEDULE

RD-1 Roof Drain: Smith figure 101-ERC cast iron body with combined flashing clamp and cast iron gravel stop, cast iron dome, extension, sump receiver and underdeck clamp.

RDO-1 Overflow Roof Drain: Smith figure 1080-ERC cast iron body with flashing clamp, gravel stop, cast iron dome, 2” high water collar, extension, sump receiver and underdeck clamp.

DSN-1 Downspout nozzle: Smith figure 1770 downspout nozzle; cast bronze body and flange.

END OF SECTION 221423

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, gas-fired, high-efficiency direct vent, storage, domestic-water heaters.
2. Domestic-water heater accessories.
3. Water heaters to come with orifice sized for the site elevation.

1.3 SEISMIC REQUIREMENTS

A. Component Importance Factor: All plumbing components shall be assigned a component importance factor. The component importance factor, I*p*, shall be taken as 1.5 if any of the following conditions apply:

1. The component is required to function for life-safety purposes after an earthquake.
2. The component contains hazardous materials.
3. The component is in or attached to an Occupancy Category IV structure and it is needed for continued operation of the facility or its failure could impair the continued operation of the facility.

B. All other components shall be assigned a component importance factor, I*p*, equal to 1.0.

1.4 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Plumbing equipment, hangers and supports shall withstand the effects of earthquake motions determined according to SEI/ASCE 7 and with the requirements specified in Section 220548 " Vibration and Seismic Controls for Plumbing Piping and Equipment.

1. For components with a seismic importance factor of 1.0 the term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified."

2. For components with a seismic importance factor of 1.5 the term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified and the system will be fully operational after the seismic event."

1.5 ACTION SUBMITTALS

A. Product Data: For each type and size of domestic-water heater indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. LEED Submittals:

1. Product Data for Prerequisite EA 2: Documentation indicating that units comply with applicable requirements in ASHRAE/IESNA 90.1, Section 7, "Service Water Heating."

C. Shop Drawings:

1. Wiring Diagrams: For power, signal, and control wiring.

1.6 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For fuel-fired, domestic-water heaters, 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 domestic-water heater, from manufacturer.

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. Warranty: Sample of special warranty.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuel-fired, domestic-water heaters to include in emergency, operation, and maintenance manuals.

1.8 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/IESNA Compliance: Fabricate and label fuel-fired, domestic-water heaters to comply with ASHRAE/IESNA 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, "Drinking Water System Components - Health Effects."

1.9 COORDINATION

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

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which 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: Two year(s).

b. Compression Tanks: Five years.

PART 2 - PRODUCTS

A. Commercial, Gas-Fired, High-Efficiency Direct Vent, Storage, Domestic-Water Heaters:

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

   a. AERCO International, Inc.
   b. Lochinvar Corporation.
   c. PVI Industries, LLC.
   d. RBI Water Heaters; a Mestek company.
   e. Smith, A. O. Water Products Co.; a division of A. O. Smith Corporation.
   f. State Industries.
   g. Weben-Jarco, Inc.

2. Standard: ANSI Z21.10.3/CSA 4.3.
3. Description: Manufacturer's proprietary design to provide at least 88 percent combustion efficiency at optimum operating conditions.
4. Storage-Tank Construction: ASME-code steel with 150-psig (1035-kPa) 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 according to ASME B1.20.1.
      2) NPS 2-1/2 (DN 65) and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.

   b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
   c. Lining: Glass complying with NSF 61 barrier materials for potable-water tank linings, including extending lining into and through tank fittings and outlets.

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 complying with ASSE 1005.
   d. Insulation: Comply with ASHRAE/IESNA 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-M. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.

6. Direct-vent System: Manufacture's standard through-wall or roof, double channel vent assembly with outside intake/exhaust screen. See drawings on vent locations room or wall.

B. Capacity and Characteristics: See drawings.

2.2 WATER HEATER ACCESSORIES

A. Domestic-Water Compression Tanks:

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

   a. AMTROL Inc.
   b. Smith, A. O. Water Products Co.; a division of A. O. Smith Corporation.
   c. State Industries.
   d. Taco, Inc.

2. 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.
3. 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 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
   c. Air-Charging Valve: Factory installed.

4. Capacity and Characteristics: See drawings

   a. Working-Pressure Rating: 150 psig (1035 kPa).
   b. Capacity Acceptable: See drawings 4 gallon minimum.
   c. Air Precharge Pressure:

B. Drain Pans: Corrosion-resistant metal with raised edge. Comply with ANSI/CSA LC 3. Include dimensions not less than base of domestic-water heater, and include drain outlet not less than NPS 3/4 (DN 20) with ASME B1.20.1 pipe threads or with ASME B1.20.7 garden-hose threads.

C. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1 or ASHRAE 90.2.

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 calibrated balancing valves to provide balanced flow through each domestic-water heater.

1. Comply with requirements for ball-, butterfly-, or gate-type shutoff valves specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
2. Comply with requirements for balancing valves specified in Division 22 Section "Domestic Water Piping Specialties."

F. Gas Shutoff Valves: ANSI Z21.15/CSA 9.1-M, manually operated. Furnish for installation in piping.

G. Gas Pressure Regulators: ANSI Z21.18/CSA 6.3, appliance type. Include required pressure regulators as required to match gas supply and equipment being served.

H. Automatic Gas Valves: ANSI Z21.21/CSA 6.5, appliance, electrically operated, on-off automatic valve.

I. Combination Temperature-and-Pressure Relief Valves: Include relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.

1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4-M.

J. Pressure Relief Valves: Include pressure setting less than domestic-water heater working-pressure rating.

1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4-M.

K. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4-M.

L. Domestic-Water Heater Stands: Manufacturer's factory-fabricated steel stand for floor mounting, capable of supporting domestic-water heater and water. Provide dimension that will support bottom of domestic-water heater a minimum of 18 inches (457 mm) above the floor.

M. Domestic-Water Heater Mounting Brackets: Manufacturer's factory-fabricated steel bracket for wall mounting, capable of supporting domestic-water heater and water.

2.3 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect assembled domestic-water heaters and storage tanks specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.

B. Hydrostatically test domestic-water heaters and storage tanks 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. Comply with requirements in Division 01 Section "Quality Requirements" for retesting and reinspecting requirements and Division 01 Section "Execution" for requirements for correcting the Work.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 WATER HEATER INSTALLATION

A. Commercial, Domestic-Water Heater Mounting: Install commercial domestic-water heaters on concrete base. Comply with requirements for concrete base specified in Division 03 Section " Miscellaneous 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 (450-mm) 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, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Division 22 Section "General-Duty Valves for Plumbing Piping."

C. Install gas-fired, domestic-water heaters according to 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 Division 23 Section "Facility Natural-Gas Piping."

D. Install commercial domestic-water heaters with seismic-restraint devices. Comply with SEI/ASCE 7 and with requirements for seismic-restraint devices specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

E. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-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 combination temperature-and-pressure relief valves in water piping for domestic-water heaters without storage. Extend commercial-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.

G. 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 Division 22 Section "Domestic Water Piping Specialties."

H. Install thermometer on outlet piping of domestic-water heaters. Comply with requirements for thermometers specified in Division 22 Section "Meters and Gages for Plumbing Piping."

I. 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 Division 22 Section "General-Duty Valves for Plumbing Piping," and comply with requirements for thermometers specified in Division 22 Section "Meters and Gages for Plumbing Piping."

J. Install piping-type heat traps on inlet and outlet piping of domestic-water heater storage tanks without integral or fitting-type heat traps.

K. Fill domestic-water heaters with water.

L. Charge domestic-water compression tanks with air.

3.2 CONNECTIONS

A. Comply with requirements for domestic-water piping specified in Division 22 Section "Domestic Water Piping."

B. Comply with requirements for gas piping specified in Division 23 Section "Facility Natural-Gas Piping."

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

D. 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 Division 22 Section "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
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 operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Division 01 Section "Quality Requirements" for retesting and reinspecting requirements and Division 01 Section "Execution" for requirements for correcting the Work.

C. Prepare test and inspection reports.

3.5 DEMONSTRATION

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

END OF SECTION 223400

SECTION 224000 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following conventional plumbing fixtures and related components:

1. Faucets for lavatories bathtub/showers showers and sinks.
2. Flushometers.
3. Toilet seats.
4. Protective shielding guards.
5. Fixture supports.
6. Water closets.
7. Urinals.
8. Lavatories.
9. Commercial sinks.
10. Kitchen sinks.
11. Service sinks.

B. Related Sections include the following:

1. Division 10 Section "Toilet, Bath, and Laundry Accessories."
2. Division 22 Section "Domestic Water Piping Specialties" for backflow preventers, floor drains, and specialty fixtures not included in this Section.
3. Division 22 Section "Emergency Plumbing Fixtures."
4. Division 22 Section "Drinking Fountains and Water Coolers."

1.3 LEAD FREE REQUIREMENTS

A. For all projects within the United States, and when water is anticipated for human consumption, all pipes, pipe fittings, plumbing fittings and fixtures shall comply with PUBLIC LAW 111-380 “Reduction of Lead in Drinking Water Act” 124 STAT. 4131, 42-USC 1201, January 4th, 2011.

1.4 DEFINITIONS

A. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.

B. Cast Polymer: Cast-filled-polymer-plastic material. This material includes cultured-marble and solid-surface materials.

C. Cultured Marble: Cast-filled-polymer-plastic material with surface coating.

D. Fitting: Device that controls the flow of water into or out of the plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads and tub spouts, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.

E. FRP: Fiberglass-reinforced plastic.

F. PMMA: Polymethyl methacrylate (acrylic) plastic.

G. PVC: Polyvinyl chloride plastic.

H. Solid Surface: Nonporous, homogeneous, cast-polymer-plastic material with heat-, impact-, scratch-, and stain-resistance qualities.

I. Lead Free:
1. Not containing more than 0.2 percent lead when used with respect to solder and flux.
2. Not more than a weighted average of 0.25 percent lead when used with respect to the wetted surfaces of pipes, pipe fittings, plumbing fittings and fixtures.
3. Calculation: The weighted average lead content of a pipe, pipe fitting, plumbing fitting or fixture shall be calculated by using the formula prescribed in the law named in LEAD FREE REQUIREMENTS above.

1.5 SUBMITTALS

A. Product Data: For each type of plumbing fixture indicated. Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow-control rates.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Operation and Maintenance Data: For plumbing fixtures to include in emergency, operation, and maintenance manuals.

D. Warranty: Special warranty specified in this Section.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.

1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.

D. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.

E. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

F. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

G. Comply with the following applicable standards and other requirements specified for plumbing fixtures:

1. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.
2. Porcelain-Enameled, Formed-Steel Fixtures: ASME A112.19.4M.
3. Slip-Resistant Bathing Surfaces: ASTM F 462.
4. Solid-Surface-Material Lavatories and Sinks: ANSI/ICPA SS-1.
5. Stainless-Steel Residential Sinks: ASME A112.19.3.
6. Vitreous-China Fixtures: ASME A112.19.2M.
7. Water-Closet, Flushometer Tank Trim: ASSE 1037.
8. Whirlpool Bathtub Fittings: ASME A112.19.8M.

H. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:

1. Backflow Protection Devices for Faucets with Side Spray: ASME A112.18.3M.
2. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.
3. Diverter Valves for Faucets with Hose Spray: ASSE 1025.
4. Faucets: ASME A112.18.1.
5. Hose-Connection Vacuum Breakers: ASSE 1011.
6. Hose-Coupling Threads: ASME B1.20.7.
7. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
8. NSF Potable-Water Materials: NSF 61.
9. Pipe Threads: ASME B1.20.1.
10. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
11. Supply Fittings: ASME A112.18.1.

12. Brass Waste Fittings: ASME A112.18.2.
13. NSF61 Appendage G-AB 1953. Lead free potable drinking faucets.

I. Comply with the following applicable standards and other requirements specified for bathtub/shower and shower faucets:

1. Backflow Protection Devices for Hand-Held Showers: ASME A112.18.3M.
2. Combination, Pressure-Equalizing and Thermostatic-Control Antiscald Faucets: ASSE 1016.
3. Deck-Mounted Bath/Shower Transfer Valves: ASME 18.7.
4. Faucets: ASME A112.18.1.
5. Hand-Held Showers: ASSE 1014.
6. High-Temperature-Limit Controls for Thermal-Shock-Preventing Devices: ASTM F 445.
7. Hose-Coupling Threads: ASME B1.20.7.
8. Manual-Control Antiscald Faucets: ASTM F 444.
9. Pipe Threads: ASME B1.20.1.
10. Pressure-Equalizing-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.
11. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
12. Thermostatic-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.

J. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:

1. Atmospheric Vacuum Breakers: ASSE 1001.
2. Brass and Copper Supplies: ASME A112.18.1.
3. Dishwasher Air-Gap Fittings: ASSE 1021.
4. Manual-Operation Flushometers: ASSE 1037.
5. Plastic Tubular Fittings: ASTM F 409.
6. Brass Waste Fittings: ASME A112.18.2.
7. Sensor-Operation Flushometers: ASSE 1037 and UL 1951.
8. NSF61 Appendage G-AB 1953. Lead free potable drinking faucets.

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

1. Disposers: ASSE 1008 and UL 430.
2. Dishwasher Air-Gap Fittings: ASSE 1021.
3. Flexible Water Connectors: ASME A112.18.6.
4. Floor Drains: ASME A112.6.3.
5. Grab Bars: ASTM F 446.
6. Hose-Coupling Threads: ASME B1.20.7.
7. Off-Floor Fixture Supports: ASME A112.6.1M.
8. Pipe Threads: ASME B1.20.1.
9. Plastic Toilet Seats: ANSI Z124.5.
10. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.7 EXTRA MATERIALS

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

1. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.
2. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.
3. Flushometer Valve, Repair Kits: Equal to 10 percent of amount of each type installed, but no fewer than 12 of each type.
4. Provide hinged-top wood or metal box, or individual metal boxes, with separate compartments for each type and size of extra materials listed above.
5. Toilet Seats: Equal to 5 percent of amount of each type installed.

PART 2 - PRODUCTS

2.1 LEAD FREE PRODUCTS:

A. For all products purchased that where water is anticipated for human consumption, all pipes, pipe fittings, plumbing fittings and fixtures shall comply with the LEAD FREE REQUIREMENTS in PART 1 above.

2.2 LAVATORY FAUCETS

A. Lavatory Faucets:

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

a. Chicago Faucets.
b. Moen, Inc.

2.3 BATHTUB/SHOWER FAUCETS

A. Bathtub/Shower Faucets:

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

a. Chicago Faucets.
b. Leonard Valve Company.
c. Moen, Inc.
d. Powers; a Watts Industries Co.

e. Symmons Industries, Inc.

2.4 SHOWER FAUCETS

A. Shower Faucets:

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

   a. Chicago Faucets.
   b. Leonard Valve Company.
   c. Moen, Inc.
   d. Powers; a Watts Industries Co.
   e. Symmons Industries, Inc.

2.5 SINK FAUCETS

A. Sink Faucets:

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

   a. Chicago Faucets.
   b. Moen, Inc.

2.6 FLUSHOMETERS

A. Flushometers:

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

   a. Sloan Valve Company.
   b. Zurn Plumbing Products Group; Commercial Brass Operation.
   c. Moen, Inc.

2.7 TOILET SEATS

A. Toilet Seats:

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

   a. Bemis Manufacturing Company.

b. Centoco Manufacturing Corp.
c. Church Seats.
d. Olsonite Corp.
e. Sperzel.

2. Description: Toilet seat for water-closet-type fixture.

a. Material: Molded, solid plastic with antimicrobial agent.
b. Configuration: Open front without cover.
c. Size: Elongated.
d. Hinge Type: CK, check.
e. Class: Heavy-duty commercial.
f. Color: White.

2.8 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers:

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

a. Engineered Brass Co.
b. Insul-Tect Products Co.; a Subsidiary of MVG Molded Products.
c. McGuire Manufacturing Co., Inc.
d. Plumberex Specialty Products Inc.
e. TCI Products.
f. TRUEBRO, Inc.
g. Zurn Plumbing Products Group; Tubular Brass Plumbing Products Operation.

2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements. Product shall also meet the ASTM E 84 25/450 smoke and flame rating.

B. Protective Shielding Piping Enclosures:

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

a. TRUEBRO, Inc.

2. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

2.9 FIXTURE SUPPORTS

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

1. Josam Company.
2. MIFAB Manufacturing Inc.
3. Smith, Jay R. Mfg. Co.
4. Tyler Pipe; Wade Div.
5. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.
6. Zurn Plumbing Products Group; Specification Drainage Operation.

B. Urinal Supports:

1. Description: Type I, urinal carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture for wall-mounting, urinal-type fixture. Include steel uprights with feet.
2. Accessible-Fixture Support: Include rectangular steel uprights.

C. Lavatory Supports:

1. Description: Type II, lavatory carrier with concealed arms and tie rod for wall-mounting, lavatory-type fixture. Include steel uprights with feet.
2. Accessible-Fixture Support: Include rectangular steel uprights.

2.10 WATER CLOSETS

A. Water Closets:

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

a. American Standard Companies, Inc.
b. Crane Plumbing, L.L.C./Fiat Products.
c. Eljer.
d. Kohler Co.

2.11 URINALS

A. Urinals:

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

a. American Standard Companies, Inc.
b. Briggs Plumbing Products, Inc.

c. Crane Plumbing, L.L.C./Fiat Products.
d. Eljer.
e. Kohler Co.

2.12 LAVATORIES

A. Lavatories:

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

a. American Standard Companies, Inc.
b. Briggs Plumbing Products, Inc.
c. Crane Plumbing, L.L.C./Fiat Products.
d. Eljer.
e. Kohler Co.

2.13 COMMERCIAL SINKS

A. Commercial Sinks:

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

a. Elkay Manufacturing Co.
b. Just Manufacturing Company.

2.14 SERVICE SINKS

A. Service Sinks:

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

a. American Standard Companies, Inc.
b. Commercial Enameling Company.
c. Eljer.
d. Kohler Co.
e. Crane Plumbing, L.L.C./Fiat Products.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing fixture installation.

B. Examine cabinets, counters, floors, and walls for suitable conditions where fixtures will be installed.

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

3.2 INSTALLATION

A. Installations where water is anticipated for human consumption, all pipes, pipe fittings, plumbing fittings and fixtures shall be Lead Free as given in PART 1 above.

B. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.

C. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.

1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.

D. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.

E. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.

F. Install wall-mounting fixtures with tubular waste piping attached to supports.

G. Install counter-mounting fixtures in and attached to casework.

H. Install fixtures level and plumb according to roughing-in drawings.

I. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.

1. Exception: Use ball, gate, or globe valves if supply stops are not specified with fixture. Valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."

J. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.

K. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.

L. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.

M. Install toilet seats on water closets.

N. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

O. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves.

P. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

Q. Install shower flow-control fittings with specified maximum flow rates in shower arms.

R. Install traps on fixture outlets.

1. Exception: Omit trap on fixtures with integral traps.
2. Exception: Omit trap on indirect wastes, unless otherwise indicated.

S. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Division 22 Section "Common Work Results for Plumbing."

T. Set bathtubs and service basins in leveling bed of cement grout. Grout is specified in Division 22 Section "Common Work Results for Plumbing."

U. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section "Joint Sealants."

U. All plumbing fixtures are to be mounted at the height specified on the Architectural drawings.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.

B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.

C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.

D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

E. Install fresh batteries in sensor-operated mechanisms.

3.5 ADJUSTING

A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

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

C. Replace washers and seals of leaking and dripping faucets and stops.

D. Install fresh batteries in sensor-operated mechanisms.

3.6 CLEANING

A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:

1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
2. Remove sediment and debris from drains.

B. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

3.7 PROTECTION

A. Provide protective covering for installed fixtures and fittings.

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

3.8 KITCHEN EQUIPMENT

A. Kitchen Equipment (as noted on Kitchen Equipment Schedule):

1. Rough-in and connect to Kitchen equipment as per the Kitchen Equipment Rough-in drawings. Provide all "P" traps required, chrome-plated cast brass. Tail pieces and trap arms shall be chrome-plated 17 ga. brass tubing.
2. Provide Precision Plumbing Products water hammer arrestors upstream of all quick-closing valves, such as on disposers and dishwasher.
3. Gas and water services to portable and countertop appliances shall be connected to equipment with flexible tubing and quick-disconnect fittings. Gas fittings and hoses shall be A.G.A. approved for commercial kitchen equipment.
4. All exposed piping and fittings shall be chrome-plated or stainless steel. Furnish and install stops on all hot and cold water lines at equipment.
5. Provide shut-off valves and unions in all gas, steam and condensate lines at each connection to equipment.
6. All piping penetrations through walls shall be a minimum of 6" above the floor.
7. Provide 3/4" Watts model U5BLP pressure reducing valve on supply line to dishwasher.
8. Provide check valves on supplies to hose sprays.

END OF SECTION 224000

SECTION 224223 - COMMERCIAL SHOWERS, RECEPTORS, AND BASINS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Individual showers.
2. Shower faucets.
3. Grout.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. LEED Submittals:

1. Product Data for Prerequisite WE 1 and Credit WE 3, Credit WE 2, and Credit WE 3: Documentation indicating flow and water consumption requirements.
2. Product Data for Prerequisite WE 1: Documentation indicating flow and water consumption requirements.
3. Product Data for Prerequisite WE 1 and Credit WE 2: Documentation indicating flow and water consumption requirements.

1.3 CLOSEOUT SUBMITTALS

A. Maintenance data.

PART 2 - PRODUCTS

2.1 INDIVIDUAL SHOWERS

A. Individual FRP Showers:

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

a. Aqua Glass Corporation.
b. Clarion Bathware.
c. Florestone Products Co., Inc.
d. LASCO Bathware.
e. MAAX.

f. MAAX; Aker Division.
g. Praxis Industries, LLC.; Aquarius Bathware.
h. Sterling; a Kohler company.
i. Swan Corporation (The).

2. General: FRP, accessible, shower enclosure with faucet and receptor and appurtenances.
3. Standard: ANSI Z124.1.2.
4. Type: See schedule.
5. Faucet: See schedule and "Shower Faucets" Article.
6. Outlet: Drain with NPS 2 (DN 50) outlet.
7. Grab Bar: ASTM F 446, mounted on support area back wall.

B. Individual PMMA Showers:

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

a. Acryline USA, Inc.
b. Aqua Bath Company, Inc.
c. Aqua Glass Corporation.
d. Aquatic Industries, Inc.
e. Clarion Bathware.
f. Crane Plumbing, L.L.C.
g. Jacuzzi Inc.
h. Kohler Co.
i. LASCO Bathware.
j. MAAX.
k. Praxis Industries, LLC.; Aquarius Bathware.

2. General: PMMA shower enclosure with faucet and receptor and appurtenances.
3. Standard: ANSI Z124.1.2.
4. Type: See schedule.
5. Coordinate "Faucet" Subparagraph below with "Shower Faucets" Article.
6. Faucet: see schedule and "Shower Faucets" Article.
7. Outlet: Drain with NPS 2 (DN 50) outlet.
8. Grab Bar: ASTM F 446, mounted on support area back wall.

2.2 SHOWER FAUCETS

A. NSF Standard: Comply with NSF 61, "Drinking Water System Components - Health Effects," for shower materials that will be in contact with potable water.

B. Shower Faucets:

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

a. American Standard America.
b. Chicago Faucets.
c. Ferguson Enterprises, Inc.; ProFlo Brand.
d. Kohler Co.
e. Lawler Manufacturing Co., Inc.
f. Leonard Valve Company.
g. Matco-Norca.
h. Moen Incorporated.
i. Powers; a division of Watts Water Technologies, Inc.
j. Speakman Company.
k. Zurn Industries, LLC; AquaSpec Commercial Faucet Products.

2. Description: Single-handle, pressure-balance mixing valve with hot- and cold-water indicators; check stops; and shower head.
3. Faucet:

a. Standards: ASME A112.18.1/CSA B125.1 and ASSE 1016.
b. Body Material: Solid brass.
c. Finish: See schedule.
d. Mounting: Concealed.
e. Antiscald Device: Integral with mixing valve.
f. Check Stops: Check-valve type, integral with or attached to body; on hot- and cold-water supply connections.

4. Supply Connections: NPS 1/2 (DN 15).
5. Shower Head:

a. Standard: ASME A112.18.1/CSA B125.1.
b. Type: See schedule. .

C. Shower Faucets:

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

a. Chicago Faucets.
b. Lawler Manufacturing Co., Inc.
c. Leonard Valve Company.
d. Powers; a division of Watts Water Technologies, Inc.

2. Description: Single-handle, thermostatic mixing valve with hot- and cold-water indicators; check stops; and shower head.
3. Faucet:

a. Standards: ASME A112.18.1/CSA B125.1 and ASSE 1016.
b. Body Material: Solid brass.
c. Finish: See schedule.
d. Mounting: Concealed.

e. Antiscald Device: Integral with mixing valve.
f. Check Stops: Check-valve type, integral with or attached to body; on hot- and cold-water supply connections.

4. Supply Connections: NPS 1/2 (DN 15).
5. Shower Head:

a. Standard: ASME A112.18.1/CSA B125.1.
b. Type: See schedule

2.3 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 (34.5-MPa), 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Assemble shower components according to manufacturers' written instructions.

B. Install showers level and plumb according to roughing-in drawings.

C. Install water-supply piping with stop on each supply to each shower faucet.

1. Exception: Use ball, gate, or globe valves if supply stops are not specified with shower. Comply with valve requirements specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
2. Install stops in locations where they can be easily reached for operation.

D. Install shower flow-control fittings with specified maximum flow rates in shower arms.

E. Set shower receptors 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 Division 22 Section "Escutcheons for Plumbing Piping."

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 Division 07 Section "Joint Sealants."

3.2 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 Division 22 Section "Domestic Water Piping."

C. Comply with traps and soil and waste piping requirements specified in Division 22 Section "Sanitary Waste and Vent Piping."

3.3 ADJUSTING

A. Operate and adjust showers and controls. Replace damaged and malfunctioning showers, fittings, and controls.

B. Adjust water pressure at faucets to produce proper flow.

3.4 CLEANING AND PROTECTION

A. After completing installation of showers, inspect and repair damaged finishes.

B. Clean showers, faucets, 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.

3.5 FIXTURE SCHEDULE

END OF SECTION 224223

SECTION 224700 - DRINKING FOUNTAINS AND WATER COOLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following drinking fountains and water coolers and related components:
   1. Water coolers.
   2. Fixture supports.

1.3 SEISMIC REQUIREMENTS

A. Component Importance Factor: All plumbing components shall be assigned a component importance factor. The component importance factor, I*p*, shall be taken as 1.5 if any of the following conditions apply:

   1. The component is required to function for life-safety purposes after an earthquake.
   2. The component contains hazardous materials.
   3. The component is in or attached to an Occupancy Category IV structure and it is needed for continued operation of the facility or its failure could impair the continued operation of the facility.

B. All other components shall be assigned a component importance factor, I*p*, equal to 1.0.

C. Seismic Performance: Plumbing equipment, hangers and supports shall withstand the effects of earthquake motions determined according to SEI/ASCE 7 and with the requirements specified in Section 220548 " Vibration and Seismic Controls for Plumbing Piping and Equipment.

   1. For components with a seismic importance factor of 1.0 the term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified."

   2. For components with a seismic importance factor of 1.5 the term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified and the system will be fully operational after the seismic event."

1.4 DEFINITIONS

A. Accessible Drinking Fountain or Water Cooler: Fixture that can be approached and used by people with disabilities.

B. Cast Polymer: Dense, cast-filled-polymer plastic.

C. Drinking Fountain: Fixture with nozzle for delivering stream of water for drinking.

D. Fitting: Device that controls flow of water into or out of fixture.

E. Fixture: Drinking fountain or water cooler unless one is specifically indicated.

F. Remote Water Cooler: Electrically powered equipment for generating cooled drinking water.

G. Water Cooler: Electrically powered fixture for generating and delivering cooled drinking water.

1.5 SUBMITTALS

A. Product Data: For each fixture indicated. Include rated capacities, furnished specialties, and accessories.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For fixtures to include in emergency, operation, and maintenance manuals.

E. Manufacturer Seismic Qualification Certification: Submit certification that plumbing equipment and components will withstand seismic forces defined in Division 22 Section "Mechanical Vibration and Seismic Controls." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act" ; and Public Law 101-336, "Americans with Disabilities Act" ; for fixtures for people with disabilities.

C. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

D. ARI Standard: Comply with ARI's "Directory of Certified Drinking Water Coolers" for style classifications.

E. ARI Standard: Comply with ARI 1010, "Self-Contained, Mechanically Refrigerated Drinking-Water Coolers," for water coolers and with ARI's "Directory of Certified Drinking Water Coolers" for type and style classifications.

F. ASHRAE Standard: Comply with ASHRAE 34, "Designation and Safety Classification of Refrigerants," for water coolers. Provide HFC 134a (tetrafluoroethane) refrigerant, unless otherwise indicated.

PART 2 - PRODUCTS

2.1 WATER COOLERS

A. Water Coolers:

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

   a. Elkay Manufacturing Co.
   b. Filtrine Manufacturing Company; Drinking Water Division.
   c. Halsey Taylor.
   d. Haws Corporation.
   e. Oasis Corporation.
   f. Sunroc Corp.

2.2 FIXTURE SUPPORTS

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

1. Josam Co.
2. MIFAB Manufacturing, Inc.
3. Smith, Jay R. Mfg. Co.
4. Tyler Pipe; Wade Div.
5. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.
6. Zurn Plumbing Products Group; Specification Drainage Operation.

B. Description: ASME A112.6.1M, water cooler carriers. Include vertical, steel uprights with feet and tie rods and bearing plates with mounting studs matching fixture to be supported.

1. Type I: Hanger-type carrier with two vertical uprights.
2. Type II: Bilevel, hanger-type carrier with three vertical uprights.
3. Supports for Accessible Fixtures: Include rectangular, vertical, steel uprights instead of steel pipe uprights.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water and waste piping systems to verify actual locations of piping connections before fixture installation. Verify that sizes and locations of piping and types of supports match those indicated.

B. Examine walls and floors for suitable conditions where fixtures are to be installed.

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

3.2 APPLICATIONS

A. Use carrier off-floor supports for wall-mounting fixtures, unless otherwise indicated.

B. Use mounting frames for recessed water coolers, unless otherwise indicated.

C. Set freestanding and pedestal drinking fountains on floor.

D. Set remote water coolers on floor, unless otherwise indicated.

E. Use chrome-plated brass or copper tube, fittings, and valves in locations exposed to view. Plain copper tube, fittings, and valves may be used in concealed locations.

3.3 INSTALLATION

A. Install off-floor supports affixed to building substrate and attach wall-mounting fixtures, unless otherwise indicated.

B. Install mounting frames affixed to building construction and attach recessed water coolers to mounting frames, unless otherwise indicated.

C. Install fixtures level and plumb. For fixtures indicated for children, install at height required by authorities having jurisdiction.

D. Install water-supply piping with shutoff valve on supply to each fixture to be connected to water distribution piping. Use ball, gate, or globe valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."

E. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.

F. Install pipe escutcheons at wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding pipe fittings. Escutcheons are specified in Division 22 Section "Common Work Results for Plumbing."

G. Seal joints between fixtures and walls and floors using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section "Joint Sealants."

H. Comply with SEI/ASCE 7 and with requirements for seismic-restraint devices in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.5 FIELD QUALITY CONTROL

A. Water Cooler Testing: After electrical circuitry has been energized, test for compliance with requirements. Test and adjust controls and safeties.

1. Remove and replace malfunctioning units and retest as specified above.
2. Report test results in writing.

3.6 ADJUSTING

A. Adjust fixture flow regulators for proper flow and stream height.

B. Adjust water cooler temperature settings.

3.7 CLEANING

A. After completing fixture installation, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

B. Clean fixtures, on completion of installation, according to manufacturer's written instructions.

END OF SECTION 224700

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SECTION 23 0100 - MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.1 GENERAL CONDITIONS

A. The General Conditions of the Contract, with the amendments, supplements, forms and requirements in Division 1, and herewith made a part of this Division.

B. All sections of Division 21, 22, & 23 shall comply with the Mechanical General Requirements. The standards established in this section as to quality of materials and equipment, the type and quality of workmanship, mode of operations, safety rules, code requirements, etc., shall apply to all sections of this Division as though they were repeated in each Division.

C. Mechanical equipment that is pre-purchased if any will be assigned to the Mechanical Contractor. By assignment to the Mechanical Contractor, the Mechanical Contractor shall accept and installed the equipment and provide all warrantees and guarantees as if the Mechanical Contractor had purchased the equipment.

D. Construction Indoor-Air Quality Management
   1. Comply with SMACNA's "SMACNA IAQ Guideline for Occupied Buildings under Construction."
      a. If Owner authorizes use of permanent heating, cooling, and ventilating systems during construction period as specified in Division 01 Section "Temporary Facilities and Controls," install filter media having a MERV 8 according to ASHRAE 52.2 at each return-air inlet for the air-handling system used during construction.
      b. Replace all air filters immediately prior to occupancy.
   2. Comply with one of the following requirements:
      a. After Construction ends, prior to occupancy and with all interior finishes installed, perform a building flush-out by supplying a total volume of 14000 cu. Ft. (4 300 000L) of outdoor air per sq. ft. (sq. m) of floor area while maintaining an internal temperature of at least 60 deg F (16 deg C) and a relative humidity no higher than 60 percent.

      b. If occupancy is desired prior to flush-out completion, the space may be occupied following delivery of a minimum of 3500 cu. ft. (1 070 000 L) of outdoor air per sq. ft. (sq. m) of floor area to the space. Once a space is occupied, it shall be ventilated at a minimum rate of 0.30 cfm per sq. ft. (1.52 L/s per sq. m) of outside air or the design minimum outside air rate determined in EQ Prerequisite 1, whichever is greater. During each day of the flush-out period, ventilation shall begin a minimum of three hours prior to occupancy and continue during occupancy. These conditions shall be maintained until a total of 14000 cu. ft./sq. ft. (4 300 000 L/sq. m) of outside air has been delivered to the space.

E. LEED REQUIREMENT
1. The Contractor is to submit all LEED information needed by the Design Professional to demonstrate that particular credits have been achieved. In particular, credits that depend on knowing the cost and quantity of certain types of products cannot be achieved without obtaining that information from the Contractor. These include renewable content, locally sourced new products, and reused products. In addition, a form is provided for each installer to certify that they have not used adhesives, sealants, and for suppliers and installers to certify they have not used composite wood with prohibited VOC content.

1.2 SCOPE OF WORK

A. This work shall include all labor, materials, equipment, fixtures, and devices for the entire mechanical work and a complete operating and tested installation as required for this project.

B. This Division will schedule the boiler inspection and pay for all costs associated with certifying the boiler with the state.

1.3 CODES & ORDINANCES

A. All work shall be executed in accordance with all underwriters, public utilities, local and state rules and regulations applicable to the trade affected. Should any change in the plans and Specifications be required to comply with these regulations, the Contractor shall notify the Architect before the time of submitting his bid. After entering into contract, the Contractor will be held to complete all work necessary to meet these requirements without extra expense to the Owner. Where work required by drawings or specifications is above the standard required, it shall be done as shown or specified.

B. Applicable codes:
1. Utah Boiler and Pressure Vessel Rules and Regulations-2013 Edition
2. International Building code- 2012 Edition
3. International Mechanical Code- 2012 Edition
4. International Plumbing Code- 2012 Edition
5. International Fire Code- 2012 Edition
6. International Energy Code- 2009 Edition
7. International Fuel Gas Code- 2012 Edition
8. National Electrical Code- 2011 Edition

1.4 INDUSTRY STANDARDS

A. All work shall comply with the following standards.
1. Associated Air Balance council (AABC)
2. Air Conditioning and Refrigeration Institute (ARI)
3. Air Diffusion council (ADC)
4. Air Movement and Control Association (AMCA)

5. American Gas Association (AGA)
6. American National Standards Institute (ANSI)
7. American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE)
8. American Society of Mechanical Engineers (ASME)
9. American Society of Testing Materials (ASTM)
10. American Water Works Association (AWWA)
11. Cooling Tower Institute (CTI)
12. ETL Testing Laboratories (ETL)
13. Institute of Electrical and Electronic Engineers (IEEE)
14. Hydronics Institute (HI)
15. Manufacturers Standardization Society of the Valve and Fitting Industry (MSS)
16. National Fire Protection Association (NFPA)
17. National Electrical Code (NEC)
18. National Electrical Manufacturers Association (NEMA)
19. National Electrical Safety code (NESC)
20. Utah safety Standard (OSHA), Utah State Industrial Council.
21. Sheet Metal and Air Conditioning Contractor=s National Association (SMACNA)
22. Underwriters Laboratories (UL)
23. Tubular Exchanger Manufacturers Association, Inc. (TEMA)
24. Heat Exchanger Institute (HEI)
25. Hydraulic Institute (HI)
26. Thermal Insulation Manufacturer=s Association (TIMA)
27. Scientific Apparatus Makers Association (SAMA)

B. Compliance Verification:
1. All items required by code or specified to conform to the ASME code shall be stamped with the ASME seal.
2. Form U-1, the manufacturer=s data report for pressure vessels, is to be included in the Operation and Maintenance Manuals. National Board Register (NBR) numbers shall be provided where required by code.
3. Manufactured equipment which is represented by a UL classification and/or listing, shall bear the UL or equivalent ETL label.

1.5 UTILITIES & FEES

A. All fees for permits required by this work will be paid by this division. The contractor shall obtain the necessary permits to perform this work. Unless noted otherwise, all systems furnished and or installed by this Contractor, shall be complete with all utilities, components, commodities and accessories required for a fully functioning system. This Contractor shall furnish smoke generators when required for testing, furnish glycol for glycol piping systems, full load of salt to fill brine tank for water softening system, furnish cleaners and water treatment additives.

1.6 SUBMITTALS AND SHOP DRAWINGS

A. General: As soon as possible after the contract is awarded, but in no case more than 45 calendar days thereafter, the Contractor shall submit to the Architect manufacturer's data on products and materials to be used in the installation of mechanical systems for this project. The review of the submitted data will require a minimum of **14 days.** The first day starts after the day they are received in the engineer's office to which the project is being constructed from. If the Contractors schedule requires return of submitted literature in less than the allotted time, the Contractor shall accelerate his submittal delivery date. The Contractor shall resubmit all items requiring re-review within **14 days** of returned submittals. Refer to each specification section for items requiring submittal review**. If the re-submittal is returned a 2nd time for correction the Contractor will provide the specific equipment that is specified on the drawings and/or the specifications.** Written approval of the Owner's Representative shall be obtained before installing any such equipment or materials for the project.

B. Review by the Owner's Representative is for general conformance of the submitted equipment to the project specification. **In no way** does such review relieve this Contractor of his obligation to furnish equipment and materials that comply in detail to the specification **nor does it relieve** the Contractor of his obligation to determine actual field dimensions and conditions that may affect his work. **Regardless of any items overlooked** by the submittal review, the requirements of the contract drawings and specifications **must be followed** and are not waived or superseded **in any way** by the review.

C. By description, catalog number, and manufacturer's names, standards of quality have been established by the Architect and the Engineer for certain manufactured equipment items and specialties that are to be furnished by this Division. Alternate products and equipment may be proposed for use only if specifically named in the specifications or if given written prior approval in published addenda. Design equipment is the equipment listed on the drawings or if not listed on the drawings is the equipment first named in the specifications.

D. If the Engineer is required to do additional design work to incorporate changes caused by submitting equipment or products, different than the design equipment specified, as defined above, the contractor shall reimburse the engineer for additional time and expenses at the engineer's current, recognized, hourly rates.

E. Submittal Format: At the contractor's discretion, project submittals may be in either of the formats described in the following paragraphs, but mixing the two formats is not acceptable.

1. Hardcopy Submittal Format: **Six (6)** copies of the descriptive literature covering products and materials to be used in the installation of mechanical systems for this project will be provided for review. The submittals shall be prepared in an orderly manner, contained in a 3-ring loose-leaf binder with index and identification tab for each item or group of items and for each specification section. All items shall be submitted at one time except automatic temperature control drawings and seismic restraint drawings which may be submitted separately within **120 days** of the contract award date. Partial submittals will not be reviewed until the complete submittal is received.

a. Submitted literature shall bear the Contractor's stamp, indicating that he has checked all equipment being submitted; that each item will fit into the available space with the accesses shown on the drawings; and, further, that each item conforms to the capacity and quality standards given in the contract documents.
b. Submitted literature shall clearly indicate performance, quality, and utility requirements; shall show dimension and size of connection points; and shall include derating factors that were applied for each item of equipment to provide capacity at job site elevation. Temperature control submittals shall include piping and wiring diagrams, sequence of operation and equipment. Equipment must fit into the available space with allowance for operation, maintenance, etc. Factory piped and wired equipment shall include shop drawings for all internal wiring and piping furnished with the unit.
c. Submitted literature shall clearly show all required field install wiring, piping, and accessory installations required by the Contractor to provide a complete operating system.

2. Electronic Submittal Format: Identify and incorporate information in each electronic submittal file as follows:

a. Assemble complete submittal package into a single indexed file incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.
b. Name file with submittal number or other unique identifier, including revision identifier.

c. Provide means for insertion to permanently record Contractor's review and approval markings and action taken by:

1) Architect.

d. Transmittal Form for Electronic Submittals:

1) Use one of the following options acceptable to the Owner;

a) Software-generated form from electronic project management software.
b) Eectronic form.

2) The Electronic Submittal shall contain the following information:
a) Project name.
b) Date.
c) Name and address of Architect.
d) Name of Construction Manager.
e) Name of Contractor.
f) Name of firm or entity that prepared submittal.
g) Names of subcontractor, manufacturer, and supplier.
h) Category and type of submittal.
i) Submittal purpose and description.
j) Specification Section number and title.

k) Specification paragraph number or drawing designation and generic name for each of multiple items.
l) Drawing number and detail references, as appropriate.
m) Location(s) where product is to be installed, as appropriate.
n) Related physical samples submitted directly.
o) Indication of full or partial submittal.
p) Transmittal number[, numbered consecutively].
q) Submittal and transmittal distribution record.
r) Other necessary identification.
s) Remarks.

e. Metadata: Include the following information as keywords in the electronic submittal file metadata:

1) Project name.
2) Number and title of appropriate Specification Section.
3) Manufacturer name.
4) Product name.

1.7 DRAWINGS AND MEASUREMENTS

A. Construction Drawings: The contract document drawings show the general design, arrangements, and extent of the system. In certain cases, the drawings may include details that show more nearly exact locations and arrangements; however, the locations, as shown diagrammatically, are to be regarded as general.

B. It shall be the work of this Section to make such slight alterations as may be necessary to make adjustable parts fit to fixed parts, leaving all complete and in proper shape when done. All dimensions given on the drawings shall be verified as related to this work and with the Architect's office before work is started.

C. This Section shall carefully study building sections, space, clearances, etc., and then provide offsets in piping or ductwork as required to accommodate the building structure without additional cost to the Owner. In any case and at any time during the construction process, a change in location required by obstacles or the installation of other trades not shown on the mechanical plans shall be made without charge.

D. The drawings shall not be scaled for roughing in measurements nor shall they be used as shop drawings. Where drawings are required for these purposes or where drawings must be made from field measurements, the Contractor shall take the necessary measurements and prepare the drawings. Shop drawings of the various subcontractors shall be coordinated to eliminate all interferences and to provide sufficient space for the installation of all equipment, piping, ductwork, etc.

E. The drawings and specifications have been prepared to supplement each other and they shall be interpreted as an integral unit with items shown on one and not the other being furnished and installed as though shown and called out on both.

F. Coordination Drawings: The contractor shall provide coordination drawings for mechanical rooms, fan rooms, equipment rooms, and congested areas to eliminate conflicts with equipment, piping, or work of other trades. The drawings shall be a minimum scale of 1/4 inch= 1 foot and of such detail as may be required by the Engineer to fully illustrate the work. These drawings shall include all piping, conduit, valves, equipment, and ductwork.

G. Sheet-metal shop drawings will be required for all ductwork in the entire building. These drawings will show all ductwork in the entire building and shall be coordinated with architectural, structural and electrical portions of the project. The contractor shall specifically obtain copies of the structural shop drawings and shall coordinate the ductwork shop drawings with approved structural members. These drawings shall be submitted to the engineer for review prior to any fabrication. The contractor is responsible for all modifications necessary to accommodate duct installation within the structural, architectural and electrical restrictions. These drawings, once reviewed by the engineer, will be made available to all mechanical, electrical, and fire sprinkler subcontractors to coordinate installation of their work.

1.8 CONTRACTOR'S USE OF BUILDING EQUIPMENT

A. The Contractor may use equipment such as electric motors, fans, heat exchangers, filters, etc., with the written permission of the Owner. As each piece of equipment is used (such as electric motors and fans), maintenance procedures approved by the manufacturer are to be followed. A careful record is to be kept of the length of the time the equipment is used, maintenance procedures followed, and any difficulty encountered. The record is to be submitted to the Owner upon acceptance. All fan belts and filter media (such as bearings) shall be carefully inspected just prior to acceptance. Any excessive wear noted shall require replacement. New filter media shall be installed in air handlers at the time systems are turned over to the owner.

1.9 EXISTING CONDITIONS

A. The Contractor shall carefully examine all existing conditions that might affect the mechanical system and shall compare these conditions with all drawings and specifications for work included under this contract. He shall, at such time, ascertain and check all conditions that may affect his work. No allowance shall subsequently be made in his behalf for an extra expense incurred as a result of his failure or neglect to make such examination. This Contractor shall include in his bid proposal all necessary allowances to repair or replace any item that will remain or will be removed, and any item that will be damaged or destroyed by new construction.

B. The Contractor shall remove all abandoned piping, etc., required by new construction and cap or plug openings. No capping, etc., shall be exposed in occupied areas. All openings of items removed shall be sealed to match adjacent surfaces.

C. The Contractor shall verify the exact location of all existing services, utilities, piping, etc., and make connections to existing systems as required or as shown on the drawings. The exact location of each utility line, together with size and elevation, shall be established before any on-site lines are installed. Should elevation or size of existing main utility lines make connections to them

impossible as shown on drawings, then notification of such shall immediately be given to the Owners Representative for a decision.

1.10 EQUIPMENT CAPACITIES

A. Capacities shown for equipment in the specifications and on the drawings are the minimum acceptable. No equipment shall be considered as an alternate that has capacities or performance less than that of design equipment.

B. All equipment shall give the specified capacity and performance at the job-site elevation. Manufacturers' standard ratings shall be adjusted accordingly. All capacities and performances listed on drawings or in specifications are for job-site conditions.

1.11 SEISMIC REQUIREMENTS FOR EQUIPMENT

A. All equipment shall be furnished structurally adequate to withstand seismic forces as outlined in the International Building Code. Refer to section Mechanical Vibration Controls and Seismic Restraints. Equipment bases shall be designed for direct attachment of seismic snubbers and/or seismic anchors.

1.12 COOPERATION WITH OTHER TRADES

A. The Contractor shall refer to other drawings and parts of this specification that cover work of other trades that is carried on in conjunction with the mechanical work such that all work can proceed without interference resulting from lack of coordination.

B. The Contractor shall properly size and locate all openings, chases, sleeves, equipment bases, and accesses. He shall provide accurate wiring diagrams to the Electrical Contractor for all equipment furnished under this Division.

C. The ceiling cavity must be carefully reviewed and coordinated with all trades. In the event of conflict, the installation of the mechanical equipment and piping shall be in the following order: plumbing, waste, and soil lines; supply, return, and exhaust ductwork; water piping; medical gases; fire protection piping; and pneumatic control piping.

D. The mechanical Contractor shall insure that the installation of all piping, ducts and equipment is in compliance with Articles 110-16 and 384-4 of the National Electrical Code relative to proper clearances in front of and over all electrical panels and equipment. No piping or ductwork will be allowed to run over electrical panel.

1.13 RESPONSIBILITY OF CONTRACTOR

A. The Contractor is responsible for the installation of a satisfactory piece of work in accordance with the true intent of the drawings and specifications. He shall provide, as a part of his work and

without expense, all incidental items required even though these items are not particularly specified or indicated. The installation shall be made so that its several component parts will function together as a workable system and shall be left with all equipment properly adjusted and in working order. The Contractor shall familiarize the Owner's Representative with maintenance and lubrication instructions as prepared by the Contractor and shall explain and fully instruct him relative to operating, servicing, and maintenance of them.

B. If a conflict arises between the drawings and the specifications the most stringent procedure/action shall be followed. A clarification to the engineer will help to determine the course of action to be taken. If a conflict arises between specification sections the engineer will determine which course of action is to be followed.

1.14 PIPE AND DUCT OPENINGS AND EQUIPMENT RECESSES

A. Pipe and duct chases, openings, and equipment recesses shall be provided by others only if shown on architectural or structural drawings. All openings for the mechanical work, except where plans and specifications indicate otherwise, shall be provided as work of this Division. Include openings information with coordination drawings.

B. Whether chases, recesses, and openings are provided as work of this Division or by others, this Contractor shall supervise their construction and be responsible for the correct size and location even though detailed and dimensioned on the drawings. This Contractor shall pay for all necessary cutting, repairing, and finishing if any are left out or incorrectly made. All necessary openings thru existing walls, ceilings, floors, roofs, etc. shall be provided by this Contractor unless indicated otherwise by the drawing and/or specifications.

1.15 UNFIT OR DAMAGED WORK

A. Any part of this installation that fails, is unfit, or becomes damaged during construction, shall be replaced or otherwise made good. The cost of such remedy shall be the responsibility of this Division.

1.16 WORKMANSHIP

A. Workmanship shall be the best quality of its kind for the respective industries, trades, crafts, and practices, and shall be acceptable in every respect to the Owner's representative. Nothing contained herein shall relieve the Contractor from making good and perfect work in all details in construction.

1.17 SAFETY REGULATION

A. The Contractor shall comply with all local, Federal, and OSHA safety requirements in performance with this work. (See General Conditions). This Contractor shall be required to provide equipment, supervision, construction, procedures, and all other necessary items to assure safety to life and property.

1.18 ELECTRICAL SERVICES

A. All equipment control wiring and all automatic temperature control wiring including all necessary contacts, relays, and interlocks, whether low or line voltage, except power wiring, shall be furnished and installed as work of this Division unless shown to be furnished by Division 26. All such wiring shall be in conduit as required by electrical codes. Wiring in the mechanical rooms, fans rooms and inaccessible ceilings and walls shall be installed in conduit as well. Installation of any and all wiring done under Division 21, 22 and 23 shall be in accordance with the requirements of Division 26, Electrical.

B. All equipment that requires an electrical connection shall be furnished so that it will operate properly and deliver full capacity on the electrical service available.

C. Refer to the electrical control equipment and wiring shown on the diagrams. Any changes or additions required by specific equipment furnished shall be the complete responsibility of the Contractor furnishing the equipment.

D. The Mechanical Contractor must coordinate with the Electrical Contractor to insure that all required components of control work are included and fully understood. No additional cost shall accrue to the Owner as a result of lack of such coordination.

1.19 WORK, MATERIALS, AND QUALITY OF EQUIPMENT

A. Unless otherwise specified, all materials shall be new and of the best quality of their respective kinds and all labor shall be done in a most thorough and workmanlike manner.

B. Products or equipment of any of the manufacturers cited herein or any of the products approved by the Addenda may be used. However, where lists of products are cited herein, the one first listed in the design equipment used in drawings and schedules to establish size, quality, function, and capacity standards. If other than design equipment is used, it shall be carefully checked for access to equipment, electrical and control requirements, valving, and piping. Should changes or additions occur in piping, valving, electrical work, etc., or if the work of other Contractors would be revised by the alternate equipment, the cost of all changes shall be borne as work of this Division.

C. The Execution portions of the specifications specify what products and materials may be used. Any products listed in the Product section of the specification that are not listed in the Execution portion of the specification may not be used without written approval by the Engineer.

D. The access to equipment shown on the drawings is the minimum acceptable space requirements. No equipment that reduces or restricts accessibility to this or any other equipment will be considered.

E. All major items of equipment are specified in the equipment schedules on the drawings or in these specifications and shall be furnished complete with all accessories normally supplied with the catalog item listed and all other accessories necessary for a complete and satisfactory installation.

F. All welders shall be certified in accordance with Section IX of the ASME Boiler and Pressure Vessel Code, latest Edition.

1.20 PROTECTION AGAINST WEATHER AND STORING OF MATERIALS

A. All equipment and materials shall be properly stored and protected against moisture, dust, and wind. Coverings or other protection shall be used on all items that may be damaged or rusted or may have performance impaired by adverse weather or moisture conditions. Damage or defect developing before acceptance of the work shall be made good at the Contractor's expense.

B. All open duct and pipe openings shall be adequately covered at all times.

1.21 INSTALLATION CHECK

A. An experienced, competent, and authorized representative of the manufacturer or supplier of each item of equipment indicated in the equipment schedule and the seismic supplier shall visit the site of the work and inspect, check, adjust if necessary, and approve the equipment installation. In each case, the equipment supplier's representative shall be present when the equipment is placed in operation. The equipment supplier's representative shall revisit the job site as often as necessary until all trouble is corrected and the equipment installation and operation is satisfactory to the Engineer.

B. Each equipment supplier's representative shall furnish to the Owner, through the Engineer, a written report certifying that the equipment (1) has been properly installed and lubricated; (2) is in accurate alignment; (3) is free from any undue stress imposed by connecting piping or anchor bolts; and, (4) has been operated under full load conditions and that it operated satisfactorily.

C. All costs for this work shall be included in the prices quoted by equipment suppliers.

1.22 EQUIPMENT LUBRICATION

A. The Contractor shall properly lubricate all pieces of equipment before turning the building over to the Owner. A linen tag shall be attached to each piece of equipment, showing the date of lubrication and the lubricant used. No equipment shall be started until it is properly lubricated.

B. Necessary time shall be spent with the Owner's Representative to thoroughly familiarize him with all necessary lubrications and maintenance that will be required of him.

C. Detergent oil as used for automotive purposes shall not be used for this work.

1.23 CUTTING AND PATCHING

A. No cutting or drilling in structural members shall be done without written approval of the Architect. The work shall be carefully laid out in advance, and cutting, channeling, chasing, or drilling of

floors, walls, partitions, ceilings, or other surfaces necessary for the mechanical work shall be carefully done. Any damage to building, piping, or equipment shall be repaired by professional plasterers, masons, concrete workers, etc., and all such work shall be paid for as work of this Division.

B. When concrete, grading, etc., is disturbed, it shall be restored to original condition as described in the applicable Division of this Specification.

1.24 EXCAVATION AND BACKFILLING

A. All necessary excavations and backfilling for the Mechanical phase of this project shall be provided as work of this Division. Trenches for all underground pipelines shall be excavated to the required depths. The bottom of trenches shall be compacted hard and graded to obtain required fall. Backfill shall be placed in horizontal layers, not exceeding 12 inches in thickness, and properly moistened. Each layer shall be compacted, by suitable equipment, to a density of not less than 95 percent as determined by ASTM D-1557. After pipelines have been tested, inspected, and approved, the trench shall be backfilled with selected material. Excess earth shall be hauled from the job site. Fill materials approved by the Architect shall be provided as work of this Division.

B. No trenches shall be cut near or under any footings without consultation first with the Architect's office. Any trenches or excavations more than 30 inches deep shall be tapered, shored, covered, or otherwise made absolutely safe so that no vehicle or persons can be injured by falling into such excavations, or in any way be harmed by cave-ins, shifting earth, rolling rocks, or by drowning. This protection shall be extended to all persons approaching excavation related to this work whether or not such persons are authorized to be in the vicinity of the construction.

1.25 ACCESS

A. Provide access doors in walls, ceilings and floors by this division unless otherwise noted. For access to mechanical equipment such as valves, dampers, VAV boxes, fans, controls, etc. Refer to Division 8 for door specifications. All access doors shall be 24" x 24" unless otherwise indicated or required. Coordinate location of doors with the Architect prior to installation. . If doors are not specified in Division 8, provide the following: Doors in ceilings and wall shall be equal to JR Smith No. 4760 bonderized and painted. Doors in tile walls shall be equal to JR Smith No. 4730 chrome plated. Doors in floors shall be equal to JR Smith No. 4910

B. Valves: Valve must be installed in locations where access is readily available. If access is compromised, as judged by the Mechanical Engineer, these valves shall be relocated where directed at the Contractors expense.

C. Equipment: Equipment must be installed in locations and orientations so that access to all components requiring service or maintenance will not be compromised. If access is compromised, as judged by the Mechanical Engineer, the contractor shall modify the installation as directed by the Engineer at the Contractors expense.

D. It is the responsibility of this division to install terminal boxes, valves and all other equipment and devices so they can be accessed. If any equipment or devices are installed so they cannot be accessed on a ladder a catwalk and ladder system shall be installed above the ceiling to access and service this equipment.

1.26 CONCRETE BASES AND INSERTS

A. Bases: The concrete bases shall be provided and installed as work by this divsion. This Division shall be responsible for the proper size and location of bases and shall furnish all required anchor bolts and sleeves with templates to be installed as work of Division 3, Concrete.

B. All floor-mounted mechanical equipment shall be set on 6-inch high concrete bases, unless otherwise noted or shown on drawings. Such bases shall extend 6 inches beyond equipment or mounting rails on all sides or as shown on the drawings and shall have a 1-inch beveled edge all around.

C. Inserts: Where slotted or other types of inserts required for this work are to be cast into concrete, they shall be furnished as work of this Division

D. Concrete inserts and pipe support systems shall be equal to Unistrut P3200 series for all piping where more than one pipe is suspended at a common location. Spacing of the inserts shall match the size and type of pipe and of ductwork being supported. The Unistrut insert and pipe support system shall include all inserts, vertical supports, horizontal support members, clamps, hangers, rollers, bolts, nuts, and any other accessory items for a complete pipe-supporting system.

1.27 CLEANING AND PAINTING

A. Cleaning: After all tests and adjustments have been made and all systems pronounced satisfactory for permanent operation, this Contractor shall clean all exposed piping, ductwork, insulated members, fixture, and equipment installed under this Section and leave them ready for painting. He shall refinish any damaged finish and leave everything in proper working order. The Contractor shall remove all stains or grease marks on walls, floors, glass, hardware, fixtures, or elsewhere, caused by his workman or for which he is responsible. He shall remove all stickers on plumbing fixtures, do all required patching up and repair all work of others damaged by this division of the work, and leave the premises in a clean and orderly condition.

B. Painting: Painting of exposed pipe, insulated pipe, ducts, or equipment is work of Division 9, Painting.

C. Mechanical Contractor: All equipment which is to be furnished in factory prefinished conditions by the mechanical Contractor shall be left without mark, scratch, or impairment to finish upon completion of job. Any necessary refinishing to match original shall be done. Do not paint over nameplates, serial numbers, or other identifying marks.

D. Removal of Debris, Etc: Upon completion of this division of the work, remove all surplus material and rubbish resulting from this work, and leave the premises in a clean and orderly condition.

1.28 CONTRACT COMPLETION

A. Incomplete and Unacceptable Work: If additional site visits or design work is required by the Engineer or Architect because of the use of incomplete or unacceptable work by the Contractor, then the Contractor shall reimburse the Engineer and Architect for all additional time and expenses involved.

B. Maintenance Instructions: The Contractor shall furnish the Owner complete printed and illustrated operating and maintenance instructions covering all units of mechanical equipment, together with parts lists.

C. Instructions To Owner's Representatives: In addition to any detailed instructions called for, the mechanical Contractor must provide, without expense to the Owner, competent instructors to train the Owner's representatives who will be in charge of the apparatus and equipment, in the care, adjustment, and operation of all parts on the heating, air conditioning, ventilating, plumbing, fire protection, and automatic temperature control equipment. Instruction dates shall be scheduled at time of final inspection. A written report specifying times, dates, and name of personnel instructed shall be forwarded to the Architect. A minimum of four 8-hour instruction periods shall be provided. The instruction periods will be broken down to shorter periods when requested by the Owner. The total instruction hours shall not reduced. The ATC Contractor shall provide 4 hours of instructions. The remaining hours shall be divided between the mechanical and sheet metal Contractor.

D. Guarantee: By the acceptance of any contract award for the work herein described or shown on the drawings, the Contractor assumes the full responsibility imposed by the guarantee as set forth herein and in the General Conditions, and should protect himself through proper guarantees from equipment and special equipment Contractors and from subcontractors as their interests may appear.

E. The guarantee so assumed by the Contractor and as work of this Section is as follows:
1. That the entire mechanical system, including plumbing, heating, and air-conditioning system shall be quiet in operation.
2. That the circulation of water shall be complete and even.
3. That all pipes, conduit, and connections shall be perfectly free from foreign matter and pockets and that all other obstructions to the free passage of air, water, liquid, sewage, and vent shall be removed.
4. That he shall make promptly and free of charge, upon notice from the Owner, any necessary repairs due to defective workmanship or materials that may occur during a period of one year from date of Substantial Completion.
5. That all specialties, mechanical, and patent devices incorporated in these systems shall be adjusted in a manner that each shall develop its maximum efficiency in the operation of the system; i.e., diffusers shall deliver the designed amount of air shown on drawings, thermostats shall operate to the specified limits, etc.

6. All equipment and the complete mechanical, ductwork, piping and plumbing systems shall be guaranteed for a period of one year from the date of the Architect's Certificate of Substantial Completion, this includes all mechanical, ductwork, piping and plumbing equipment and products and is not limited to boiler, chillers, coils, fans, filters etc. Any equipment supplier not willing to comply with this guarantee period shall not submit a bid price for this project. The Contractor shall be responsible for a 100-percent guarantee for the system and all items of equipment for this period. If the contractor needs to provide temporary heating or cooling to the building and or needs to insure systems are installed properly and or to meet the project schedule the guaranteed of all systems and equipment shall be as indicated above, on year from the date of the Architect's Certificate of Substantial Completion.
7. All filters used during construction shall be replaced just before equipment is turned over to the Owner, and all required equipment and parts shall be oiled. Any worn parts shall also be replaced.
8. If any systems or equipment is used for temporary heating or cooling the systems shall be protected so they remain clean. I.e. if the ductwork systems are used temporary filters and a filter holder (not duct-taped to ducts or grilles) shall be installed to insure the systems and the equipment remain clean.

1.29 CURBS

A. Unless otherwise noted in these specifications or on the documents all roof curbs for all equipment are to be provided by Division 22 and 23.

1.30 TEST RUN

A. The Mechanical Contractor shall operate the mechanical system for a minimum of 30 days to prove the operation of the system.

1.31 EQUIPMENT STARTUP AND CHECKOUT:

A. Each major piece of equipment shall be started and checked out by an authorized representative of the equipment manufacturer. A certificate indicating the equipment is operating to the satisfaction of the manufacturer shall be provided and shall be included in the commissioning report.

B. This contractor shall coordinate commissioning procedures and activities with the commissioning agent.

1.32 DEMOLITION

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

B. Proceed with demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.

C. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.

D. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.

E. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.

F. Maintain adequate ventilation when using cutting torches.

G. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.

H. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.

I. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.

J. Dispose of demolished items and materials promptly.

K. Return elements of construction and surfaces that are to remain to condition existing before selective demolition operations began.

L. Existing Facilities: Comply with building manager's requirements for using and protecting elevators, stairs, walkways, loading docks, building entries, and other building facilities during selective demolition operations.

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

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

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

P. Air-Conditioning Equipment: Remove equipment without releasing refrigerants.

END OF SECTION 23 0100

SECTION 230500 - 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 SUMMARY

A. This Section includes the following:

1. Piping materials and installation instructions common to most piping systems.
2. Transition fittings.
3. Dielectric fittings.
4. Mechanical sleeve seals.
5. Sleeves.
6. Escutcheons.
7. Grout.
8. Equipment installation requirements common to equipment sections.
9. Painting and finishing.
10. Concrete bases.
11. Supports and anchorages.
12. Link-Seal

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, and crawlspaces.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces, mechanical equipment rooms, accessible pipe shafts, accessible plumbing chases, and accessible tunnels.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for plastic materials:

1. CPVC: Chlorinated polyvinyl chloride plastic.
2. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:

1. EPDM: Ethylene-propylene-diene terpolymer rubber.
2. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Transition fittings.
2. Dielectric fittings.
3. Mechanical sleeve seals.
4. Escutcheons.

B. Welding certificates.

1.5 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for HVAC installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

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

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. Refer to individual Division 23 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, **1/8-inch** maximum thickness unless thickness or specific material is indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

2. AWWA C110, rubber, flat face, **1/8 inch** thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

F. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 TRANSITION FITTINGS

A. Plastic-to-Metal Transition Fittings: CPVC and PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

1. Manufacturers:

a. Eslon Thermoplastics.

B. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

1. Manufacturers:

a. Thompson Plastics, Inc.

2.5 DIELECTRIC FITTINGS

A. General: Assembly or fitting with insulating material isolating joined dissimilar metals, to prevent galvanic action and stop corrosion.

B. Description: Combination of copper alloy and ferrous; threaded, solder, plain, and weld-neck end types and matching piping system materials.

C. Insulating Material: Suitable for system fluid, pressure, and temperature.

D. Dielectric Unions: Factory-fabricated, union assembly, for **250-psig** minimum working pressure at **180 deg F**.

E. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for **150-** or **300-psig** minimum working pressure as required to suit system pressures.

F. Dielectric-Flange Insulation Kits: Field-assembled, companion-flange assembly, full-face or ring type. Components include neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

1. Provide separate companion flanges and steel bolts and nuts for **150-** or **300-psig** minimum working pressure as required to suit system pressures.

G. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and **300-psig** minimum working pressure at **225 deg F**.

H. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and **300-psig** minimum working pressure at **225 deg F**.

1. Manufacturers:

a. Capitol Manufacturing Co.
b. Central Plastics Company.
c. Watts Industries, Inc.; Water Products Div

2.6 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

1. Manufacturers:

a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Metraflex Co.
d. Pipeline Seal and Insulator, Inc.

2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

3. Pressure Plates: Stainless steel. Include two for each sealing element.

4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.7 SLEEVES

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

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with set screws.

E. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.

F. PVC Pipe: ASTM D 1785, Schedule 40.

2.8 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Type: With set screw.

1. Finish: Polished chrome-plated and rough brass.

D. One-Piece, Stamped-Steel Type: With set screw or spring clips and chrome-plated finish.

E. Split-Plate, Stamped-Steel Type: With concealed hinge, set screw or spring clips, and chrome-plated finish.

2.9 GROUT

A. Description: ASTM C 1107, Grade B, non-shrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume-adjusting, non-staining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: **5000-psi**, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

2.10 LINK-SEAL MODULAR SEAL PRESSURE PLATES

A. Link-Seal® modular seal pressure plates shall be molded of glass reinforced Nylon Polymer with the following properties:
1. Izod Impact - Notched = **2.05ft-lb/in.** per ASTM D-256
2. Flexural Strength @ Yield = **30,750 psi** per ASTM D-790
3. Flexural Modulus = **1,124,000 psi** per ASTM D-790
4. Elongation Break = 11.07% per ASTM D-638
5. Specific Gravity = 1.38 per ASTM D-792

B. Models LS200-275-300-315 shall incorporate the most current Link-Seal® Modular Seal design modifications and shall include an integrally molded compression assist boss on the top (bolt entry side) of the pressure plate, which permits increased compressive loading of the rubber sealing element. Models 315-325-340-360-400-410-425-475-500-525-575-600 shall incorporate an integral recess known as a "Hex Nut Interlock" designed to accommodate commercially available fasteners to insure proper thread engagement for the class and service of metal hardware. All pressure plates shall have a permanent identification of the manufacturer's name molded into it.

C. For fire service, pressure plates shall be steel with 2-part Zinc Dichromate Coating.

D. Link-Seal® Modular Seal Hardware: All fasteners shall be sized according to latest Link-Seal® modular seal technical data. Bolts, flange hex nuts shall be:

1. 316 Stainless Steel per ASTM F593-95, with a **85,000 psi** average tensile strength.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

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

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

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

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

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

J. Install piping to allow application of insulation.

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

L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:

1. New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.

b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.

c. Insulated Piping: One-piece, stamped-steel type with spring clips.

d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.

e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.

f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece or split-casting, cast-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 and set screw.

M. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.

N. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.

1. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas **2 inches** above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

2. Install sleeves in new walls and slabs as new walls and slabs are constructed.

3. Install sleeves that are large enough to provide **1/4-inch** annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

a. PVC Steel Pipe Sleeves: For pipes smaller than **NPS 6**.

b. Steel Sheet Sleeves: For pipes **NPS 6** and larger, penetrating gypsum-board partitions.

c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to **2 inches** above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.

1) Seal space outside of sleeve fittings with grout.

4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

O. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Install steel pipe for sleeves smaller than **6 inches** in diameter.
2. Install cast-iron "wall pipes" for sleeves **6 inches** and larger in diameter.
3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

P. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for **1-inch** annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

Q. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.

R. Verify final equipment locations for roughing-in.

S. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.2 PIPING JOINT CONSTRUCTION

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

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

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

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

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

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

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.3 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping **NPS 2** and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping **NPS 2-1/2** and larger, adjacent to flanged valves and at final connection to each piece of equipment.
3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

3.5 PAINTING

A. Painting of HVAC systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.6 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on **18-inch** centers around the full perimeter of the base.
3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7. Use **3000-psi**, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section " Miscellaneous Cast-in-Place Concrete."

3.7 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 5 Section "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor HVAC materials and equipment.

C. Field Welding: Comply with AWS D1.1.

3.8 GROUTING

A. Mix and install grout for HVAC equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

3.9 LINK SEAL

A. Provide Link Seal at all piping penetrations from the outside.

END OF SECTION 230500

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. Stack-sleeve fittings.
3. Sleeve-seal systems.
4. Sleeve-seal fittings.
5. Grout.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Galvanized-Steel Wall Pipes: ASTM A 53, Schedule 40, with plain ends and welded steel collar; zinc coated.

C. Galvanized-Steel-Pipe Sleeves: ASTM A 53, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

D. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

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

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

G. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

2.2 STACK-SLEEVE FITTINGS

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

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Smith, Jay R. Mfg. Co.
   2. Zurn Industries, LLC.

C. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.
   1. Underdeck Clamp: Clamping ring with setscrews.

2.3 SLEEVE-SEAL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Advance Products & Systems, Inc.
   2. CALPICO, Inc.
   3. Metraflex Company (The).
   4. Pipeline Seal and Insulator, Inc.
   5. Proco Products, Inc.

B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
   1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   2. Pressure Plates: Stainless steel.
   3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.4 SLEEVE-SEAL FITTINGS

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

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

C. Description: Manufactured plastic, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall. Unit has plastic or rubber waterstop collar with center opening to match piping OD.

2.5 GROUT

A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

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

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

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

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide Insert dimension annular clear space between piping and concrete slabs and walls.
   1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
   1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
   2. Cut sleeves to length for mounting flush with both surfaces.
      a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
   3. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.
   1. Cut sleeves to length for mounting flush with both surfaces.
   2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
   3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 079200 "Joint Sealants."

E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.2 STACK-SLEEVE-FITTING INSTALLATION

A. Install stack-sleeve fittings in new slabs as slabs are constructed.
   1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
   2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 076200 "Sheet Metal Flashing and Trim."
   3. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
   4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
   5. Using grout, seal the space around outside of stack-sleeve fittings.

B. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

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

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

3.4 SLEEVE-SEAL-FITTING INSTALLATION

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

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

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

3.5 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:
   1. Exterior Concrete Walls above Grade:
      a. Piping Smaller Than NPS 6: Cast-iron wall sleeves.
      b. Piping NPS 6 and Larger: Cast-iron wall sleeves.
   2. Exterior Concrete Walls below Grade:
      a. Piping Smaller Than NPS 6: Cast-iron wall sleeves with sleeve-seal system.
         1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
      b. Piping NPS 6 and Larger: Cast-iron wall sleeves with sleeve-seal system.
         1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
   3. Concrete Slabs-on-Grade:
      a. Piping Smaller Than NPS 6: Cast-iron wall sleeves with sleeve-seal system.
         1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
      b. Piping NPS 6 and Larger: Cast-iron wall sleeves with sleeve-seal system.
         1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
   4. Concrete Slabs above Grade:
      a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
      b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves.
   5. Interior Partitions:
      a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
      b. Piping NPS 6 and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION 23 0517

SECTION 230519 - METERS AND GAGES 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. Liquid-in-glass thermometers.
2. Thermowells.
3. Pressure gages.
4. Gage attachments.
5. Test plugs.
6. Test-plug kits.

B. Related Sections:

1. Division 23 Section "Facility Natural-Gas Piping" for gas meters.
2. Division 23 Section "Steam and Condensate Heating Piping" for steam and condensate meters.

1.3 ACTION SUBMITTALS

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

B. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

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

1.5 CLOSEOUT SUBMITTALS

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

PART 2 - PRODUCTS

2.1 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:

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

   a. Palmer Wahl Instrumentation Group.
   b. Trerice, H. O. Co.
   c. Weiss Instruments, Inc.
   d. Weksler.

2. Standard: ASME B40.200.
3. Case: Die Cast aluminum or brass; nominal size unless otherwise indicated.
4. Case Form: Adjustable angle type unless otherwise indicated, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device.
5. Tube: Glass with magnifying lens and blue organic liquid.
6. Tube Background: Satin faced, nonreflective aluminum with permanently etched scale markings graduated in deg F.
7. Window: Glass.
8. Stem: Copper-plated steel, aluminum, stainless steel, or brass designed for thermowell installation. Stem shall be of length to match thermowell insertion length.

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

   a. AMETEK, Inc.; U.S. Gauge Div.
   b. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
   c. Ernst Gage Co.
   d. Marsh Bellofram.
   e. Miljoco Corp.
   f. NANMAC Corporation.
   g. Noshok, Inc.
   h. Palmer - Wahl Instruments Inc.

i. REO TEMP Instrument Corporation.
j. Tel-Tru Manufacturing Company.
k. Trerice, H. O. Co.
l. Weiss Instruments, Inc.
m. Weksler
n. WIKA Instrument Corporation.
o. Winters Instruments.

2. Manufacturers: Same as manufacturer of thermometer being used.
3. Standard: ASME B40.200.
4. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
5. Material for Use with Copper Tubing: Brass.
6. Material for Use with Steel Piping: Brass.
7. Type: Stepped shank unless straight or tapered shank is indicated.
8. External Threads: NPS 1/2, NPS 3/4, NPS 1 or NPS 1-1/4 ASME B1.20.1 pipe threads.
9. Internal Threads: 1/2, 3/4, and 1 inch with ASME B1.1 screw threads.
10. Bore: Diameter required to match thermometer bulb or stem.
11. Insertion Length: Length required to match thermometer bulb or stem.
12. Lagging Extension: Include on thermowells for insulated piping and tubing.
13. 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, provide products by one of the following:

a. AMETEK, Inc.; U.S. Gauge.
b. Ashcroft Inc.
c. Ernst Flow Industries.
d. KOBOLD Instruments, Inc.
e. Marsh Bellofram.
f. Miljoco Corporation.
g. Noshok.
h. Palmer Wahl Instrumentation Group.
i. REOTEMP Instrument Corporation.
j. Trerice, H. O. Co.
k. Weiss Instruments, Inc.
l. Weksler
m. WIKA Instrument Corporation.
n. Winters Instruments - U.S.

2. Standard: ASME B40.100.

3. Case: Liquid-filled type; cast aluminum or drawn steel; 4-1/2-inchnominal diameter.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated. NPS 1/4 or NPS 1/2.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Satin faced, nonreflective aluminum with permanently etched scale markings graduated in psi .
8. Pointer: Dark-colored metal.
9. Window: Glass.
10. Ring: Stainless steel.
11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

B. Remote-Mounted, Metal-Case, Dial-Type Pressure Gages:

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

   a. AMETEK, Inc.; U.S. Gauge.
   b. Ashcroft Inc.
   c. Ernst Flow Industries.
   d. KOBOLD Instruments, Inc.
   e. Marsh Bellofram.
   f. Miljoco Corporation.
   g. Noshok.
   h. Palmer Wahl Instrumentation Group.
   i. REOTEMP Instrument Corporation.
   j. Trerice, H. O. Co.
   k. Weiss Instruments, Inc.
   l. Weksler
   m. WIKA Instrument Corporation.
   n. Winters Instruments - U.S.

2. Standard: ASME B40.100.
3. Case: Liquid-filled, cast aluminum or drawn steel; diameter with back flange for panel surface mounting or front flange for panel recessed mounting. Flanges to include pre-drilled screw holes.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated. NPS 1/4 or NPS 1/2.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Satin faced, nonreflective aluminum with permanently etched scale markings graduated in psi .
8. Pointer: Dark-colored metal.
9. Window: Glass.
10. Ring: Stainless steel.
11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.4 GAGE ATTACHMENTS

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

B. Siphons:
   1. Loop-shaped section: Brass pipe with pipe threads. NPS 1/4 or NPS 1/2.

C. Valves:
   1. Needle: Brass, 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, provide products by one of the following:

   1. Flow Design, Inc.
   2. MG Piping Products Co.
   3. National Meter, Inc.
   4. Peterson Equipment Co., Inc.
   5. Sisco Manufacturing Company, Inc.
   6. Trerice, H. O. Co.
   7. Twin City Hose.
   8. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
   9. Welsler.

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: or , ASME B1.20.1 pipe thread.

E. Minimum Pressure and Temperature Rating:

F. Core Inserts: Self-sealing synthetic rubber;
   1. EPDM (Nordel) for air, water or glycol operation between 30 and 275 deg F.
   2. CR (Neoprene) for air, water, glycol, oil, or gas operation between -30 to 200 deg F.

2.6 TEST-PLUG KITS

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

1. Flow Design, Inc.
2. MG Piping Products Co.
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.

B. Furnish the number of test-plug kits given below with the number of thermometers given below, with each kit having 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.

1. 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 .
2. High-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220 deg F .
3. Pressure Gage: Small, Bourdon-tube insertion type with 2- to 3-inch diameter dial and probe. Dial range shall be at least to 200 psig.
4. Carrying Case: Metal or plastic, with formed instrument padding.
5. One test-plug kit with:
   a. Two thermometers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install thermowells: with socket extending one-third of pipe diameter and in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions to most readable position.

F. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

G. Install needle-valve and snubber in piping for each pressure gage for fluids. Exception: Steam.

H. Install test plugs in piping tees.

I. Install thermometers in the following locations:

1. Inlet and outlet of each hydronic boiler.
2. Inlet and outlet of each hydronic coil in air-handling units.

J. Install pressure gages in the following locations:

1. Inlet and discharge of each pressure-reducing valve.
2. Suction and discharge of each pump.

3.2 CONNECTIONS

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

3.3 ADJUSTING

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

3.4 THERMOMETER SCHEDULE

A. Thermometers at inlet and outlet of each hydronic zone shall be one of the following:

1. Test plug: With EPDM self-sealing rubber inserts.

B. Thermometers at inlet and outlet of each hydronic boiler shall be one of the following:

1. Industrial-style, liquid-in-glass type.

C. Thermometers at inlets and outlets of each chiller shall be one of the following:

1. Industrial-style, liquid-in-glass type.

D. Thermometers at inlet and outlet of each hydronic coil in air-handling units and built-up central systems shall be one of the following:

1. Industrial-style, liquid-in-glass type.

E. Thermometers at inlet and outlet of each hydronic coil at fan coils, cabinet heaters, unit heaters and reheat coils and as shown on details shall be the following:

1. Industrial-style, liquid-in-glass type.
2. Test plug with [CR] [chlorosulfonated polyethylene synthetic] self-sealing rubber inserts.
3. Test plug with EPDM self-sealing rubber inserts.

F. Thermometers at inlets and outlets of each hydronic heat exchanger shall be the one of following:

1. Industrial-style, liquid-in-glass type.

G. Thermometers at inlet and outlet of each hydronic heat-recovery unit shall be the one of following:

1. Industrial-style, liquid-in-glass type.

H. Thermometers at inlet and outlet of each thermal-storage tank shall be one of the following:

1. Industrial-style, liquid-in-glass type.

I. Thermometer stems shall be of length to match thermowell insertion length.

3.5 THERMOMETER SCALE-RANGE SCHEDULE

A. Scale Range for Heating, Hot-Water Piping: 30 to 240 deg F.

3.6 PRESSURE-GAGE SCHEDULE

A. Pressure gages at suction and discharge of each pump shall be one of the following:

1. Liquid-filled, direct-mounted, metal case.

3.7 PRESSURE-GAGE SCALE-RANGE SCHEDULE

A. Scale Range for Chilled-Water, Condenser-Water, Heating, Hot-Water, Steam and Condensate Piping shall be twice the normal operating pressure of the measured system with gage ranges as follows:
1. 30 in. Hg to 15 psi .
2. 0 to 30 psi .
3. 0 to 100 psi .
4. 0 to 160 psi .
5. 0 to 200 psi .
6. 0 to 300 psi .
7. 0 to 600 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:
   2. Bronze ball valves.
   3. Iron, single-flange butterfly valves.
   4. Bronze swing check valves.

B. Related Sections:

   1. Section 230553 "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 ACTION SUBMITTALS

A. Product Data: For each type of valve indicated. Body material, valve design, pressure and temperature classification, end connection details, seating materials, trim material and

arrangement, dimensions and required clearances, and installation instructions. Include list indicating valve and its application.

B. Maintenance data for valves to be included in the operation and maintenance data specified in Division 1. Include detailed manufacturer's instructions on adjusting, servicing, disassembling, and repairing.

1.5 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve as listed in SUMMARY from a single source and from a single manufacturer.

B. 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.
4. MSS Compliance: Comply with the various MSS Standard Practice documents referenced.

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, and weld ends.
3. Set angle, and globe valves closed to prevent rattling.
4. Set ball and plug 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[except plug valves].
4. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every [5] [10] <Insert number> plug valves, for each size square plug-valve head.
5. 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:
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.

a. Caution: Where soldered end connections are used, use solder having a melting point below 840 deg. For, globe, and check valves: below 421 deg. F for ball valves.

3. Threaded: With threads according to ASME B1.20.1.

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

2.2 MANUFACTURERS

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

1. APCO Willamette Valve and Primer Corp.
2. Babbitt Steam Specialty Company.

3. Bray Controls.
4. Center Line.
5. Cla-Val Company.
6. Conbraco Industries Inc.
7. Crane Co.; Crane Valve Group.
8. Fisher Valve by Emerson.
9. Flo Fab Inc.
10. Flow-Tek Inc.
11. Grinnell Corporation.
12. Hammond Valve.
13. Jamesbury; a subsidiary of Metso Automation.
14. Jomar International LTD.
15. Keystone Valve USA, Inc.
16. Kitz Corp.
17. Legend Valve.
18. Metraflex Company.
19. Milwaukee Valve Company.
20. Mueller Steam Specialty.
21. NIBCO Inc.
22. Red-White Valve Corp.
23. Spence Strainers International.
24. Stockham Valves and Fittings, Inc.
25. Tyco Fire/Shurjoint Piping Products.
26. Tyco/Pentair LTD.
27. Val-Matic Valve & Mfg. Corp.
28. Victaulic Company.
29. Watts Regulator Company.

2.4 BRONZE BALL VALVES

C. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:

1. 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.

2.5 IRON, SINGLE-FLANGE BUTTERFLY VALVES

A. 150 CWP, Iron, Single-Flange (Lug) Butterfly Valves:

1. Description:

a. Standard: MSS SP-67, Type I.
b. CWP Rating: 150 psig.
c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
e. Seat: EPDM.
f. Stem: One- or two-piece stainless steel.
g. Disc: Nylon 11 coated ductile iron.

B. 175 CWP, Iron, Single-Flange (Lug) Butterfly Valves:

1. Description:
a. Standard: MSS SP-67, Type I.
b. CWP Rating: 175 psig.
c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
e. Seat: EPDM.
f. Stem: One- or two-piece stainless steel.
g. Disc: Nylon 11 coated ductile iron.

C. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Nylon 11 coated ductile Iron Disc:

1. Description:

a. Standard: MSS SP-67, Type I.
b. CWP Rating: 200 psig.
c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
e. Seat: EPDM.
f. Stem: One- or two-piece stainless steel.
g. Disc: Nylon 11 coated ductile iron.

D. 250 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Nylon 11 coated ductile Iron Disc:

1. Description:

a. Standard: MSS SP-67, Type I.
b. CWP Rating: 250 psig.

c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
e. Seat: EPDM.
f. Stem: One- or two-piece stainless steel.
g. Disc: Nylon 11 coated ductile iron.

2.6 BRONZE SWING CHECK VALVES

A. Class 150, Bronze Swing Check Valves with Bronze Disc:

1. Description:

a. Standard: MSS SP-80, Type 3.
b. CWP Rating: 300 psig.
c. Body Design: Horizontal flow.
d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded.
f. Disc: Bronze.

2.7 IRON SWING CHECK VALVES

A. Class 125, Iron Swing Check Valves with Metal Seats:

1. 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.

2.8 LUBRICATED PLUG VALVES

A. Class 125, Regular-Gland, Lubricated Plug Valves with Threaded Ends:

1. Description:

a. Standard: MSS SP-78, Type II.
b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
c. Pattern: Regular or short.
d. Body Material: ASTM A 48 or ASTM A 126, cast iron with lubrication-sealing system.

e. Plug: Cast iron or bronze with sealant groove.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine piping system for compliance3 with requirements for installation tolerances and other conditions affecting performance of valves. Do no proceed with installation until unsatisfactory conditions have been corrected.

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

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

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

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

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

3.2 VALVE INSTALLATION

A. Install valves as indicated, according to manufacturer’s written instructions.

B. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate the general arrangement of piping, fittings, and specialties.

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

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

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

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

G. Install check valves for proper direction of flow and as follows:

1. Swing Check Valves: In horizontal position with hinge pin level.
2. Check Valves: In horizontal or vertical position, between flanges.
3. Lift Check Valves: With stem upright and plumb.

4. Install all check valves a minimum of five pipe diameters downstream of pump discharge or elbow to avoid flow turbulence. In extreme cases add flow straighteners as required to correct the turbulence.

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 or butterfly valves.
2. Butterfly Valve Dead-End Service: Single-flange (lug) type.
3. Pump-Discharge Check Valves:

   a. NPS 2 and Smaller: Bronze swing check valves with bronze disc.
   b. NPS 2-1/2 and Larger: Iron swing check valves with lever and weight or with spring or iron, metal-seat check valves.

4. Drain Service (except Steam): Two-Piece, Full Port Bronze Ball Valves with Bronze Trim. To be installed with NPS ¾ hose thread outlet and hose cap with chain.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

C. Select valves, except wafer types, with the following end connections:

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

3.5 HEATING-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
3. Ball Valves:

a. Piece: Two
b. Port: Full.
c. Material/Trim: Bronze with:
1) Bronze trim.

4. Bronze Swing Check Valves:
a. Class 150
b. Bronze 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, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12:
a. 200 CWP,
b. Seat: EPDM.
c. Disc: Ductile-iron.
3. Iron Swing Check Valves: Class 125, metal seats.

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. Metal framing systems.

B. Related Sections:

1. **Division 05** for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Section 230516 "Expansion Fittings and Loops for HVAC Piping" for pipe guides and anchors.
3. Section 230548 "Vibration and Seismic Controls for HVAC" for vibration isolation devices.
4. Section 233113 "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. 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 ACTION SUBMITTALS

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

B. Shop Drawings: **Signed and sealed by a qualified professional engineer**. Show fabrication and installation details and include calculations for the following; include Product Data for components:

1. Trapeze pipe hangers.
2. Metal framing systems.

1.6 INFORMATIONAL SUBMITTALS

A. Welding certificates.

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**.

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 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

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

a. Anvil International.
b. Cooper B-Line, Inc.; a division of Cooper Industries.
c. ERICO/Michigan Hanger Co. ; ERISTRUT Div.

d. GS Metals Corp.
e. Hilti, Inc.insert manufacturer's name.
f. Power-Strut Div. Tyco International.
g. Thomas & Betts Corporation.
h. Tolco Inc.
i. Unistrut; an Atkore International company.

2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
3. Standard: MFMA-4.
4. Channels: Continuous slotted steel channel with inturned lips.
5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of **carbon steel**.
7. Metallic Coating:
   a. Electroplated zinc.

B. Non-MFMA Manufacturer Metal Framing Systems:

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

   a. Anvil International; a subsidiary of Mueller Water Products, Inc.
   b. Empire Industries, Inc.
   c. ERICO International Corporation.
   d. Haydon Corporation.
   e. NIBCO INC.
   f. PHD Manufacturing, Inc.
   g. PHS Industries, Inc.

2. Description: Shop- or field-fabricated pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
3. Standard: Comply with MFMA-4.
4. Channels: Continuous slotted steel channel with inturned lips.
5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of **carbon steel**.
7. Coating:
   a. Zinc.

2.4 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36, 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, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

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

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

E. 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.

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

G. 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.

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

I. 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.

J. Insulated Piping:

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

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

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

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

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

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

   a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
   b. NPS 4: 12 inches long and 0.06 inch thick.
   c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
   d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
   e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.

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

3.2 METAL FABRICATIONS

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

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

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

3.3 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**.

3.4 PAINTING

A. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in **Division 09**.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.5 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

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

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

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

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

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

H. 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.

I. 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.

J. 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.

K. 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.

L. 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.

M. 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.

N. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

O. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

P. Use **powder-actuated fasteners** instead of building attachments where required in concrete construction.

END OF SECTION 230529

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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 SCOPE

A. Provide engineered vibration isolation and restraint systems in accordance with the requirements of this section including design, engineering, materials, testing, inspections and reports.

B. Mechanical equipment with moving parts shall be mounted on or suspended from vibration isolators to reduce the transmission of vibration and mechanically transmitted sound to the building structure.

C. All mechanical equipment, piping and ductwork shall be restrained as required by Federal, State and Local building codes to preserve the integrity of nonstructural building components during **seismic** events to minimize hazards to occupants and reduce property damage.

1.3 SUMMARY

A. This Section includes the following:
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. Pipe-riser resilient supports.
9. Resilient pipe guides.
10. Air-spring isolators.
11. Restrained-air-spring isolators.
12. Elastomeric hangers.
13. Spring hangers.
14. Snubbers.
15. Restraint channel bracings.
16. Restraint cables.
17. Seismic-restraint accessories.

18. Mechanical anchor bolts.
19. Adhesive anchor bolts.
20. Vibration isolation equipment bases.
21. Restrained isolation roof-curb rails.
22. Certification of **seismic** restraint designs.
23. Installation supervision.
24. Design of attachment of housekeeping pads.
25. All components requiring IBC compliance and certification.
26. All inspection and test procedures for components requiring IBC compliance.
27. Restraint of all mechanical equipment, pipe and ductwork, within, on, or outdoors of the building and entry of services to the building, up to but not including, the utility connection, is part of this Specification.
28. Seismic certification of equipment

1.4 DEFINITIONS

A. IBC: International Building Code.

B. ICC-ES: ICC-Evaluation Service.

C. ASCE: American Society of Civil Engineers

D. OSHPD: Office of Statewide Health Planning and Development for the State of California.

E. Ip: Importance Factor.

F. ESSENTIAL FACILITIES, (Occupancy Category IV, IBC-2012)

1. Buildings and other structures that are intended to remain operational in the event of extreme environmental loading from flood, wind, snow or earthquakes.

G. LIFE SAFETY

1. All systems involved with fire protection, including sprinkler piping, jockey pumps, fire pumps, control panels, service water supply piping, water tanks, fire dampers, smoke exhaust systems and fire alarm panels.

2. All mechanical, electrical, plumbing or fire protection systems that support the operation of, or are connected to, emergency power equipment, including all lighting, generators, transfer switches and transformers.

3. All medical and life support systems.

4. Hospital heating systems and air conditioning systems for maintaining normal ambient temperature.

5. Automated supply, exhaust, fresh air and relief air systems on emergency control sequence, including air handlers, duct, dampers, etc., or manually-operated systems used for smoke evacuation, purge or fresh air relief by the fire department.

6. Heating systems in any facility with Occupancy Category IV, IBC-2009 where the ambient temperature can fall below 32 degrees Fahrenheit.

H. HIGH HAZARD

1. All gases or fluids that must be contained in a closed system which are flammable or combustible. Any gas that poses a health hazard if released into the environment and vented Fuel Cells.

1.5 REFERENCE CODES AND STANDARDS

A. Codes and Standards: The following shall apply and conform to good engineering practices unless otherwise directed by the Federal, State or Local authorities having jurisdiction.

1. IBC
2. ASCE 7
3. NFPA 13 (National Fire Protection Association)
4. IBC 2012 replaces all references to IBC 2006, 2009.

B. The following guides may be used for supplemental information on typical seismic installation practices. Where a conflict exists between the guides and these construction documents, the construction documents will preside.

1. FEMA (Federal Emergency Management Agency) manuals 412, Installing Seismic Restraints for Mechanical Equipment and 414, Installing Seismic Restraints for Ductwork and Pipe.
2. SMACNA (Sheet Metal and Air-conditioning Contractors' National Association) Seismic Restraint Manual Guidelines for Mechanical Systems, 3rd ed.
3. ASHRAE (American Society for Heating, Refrigerating and Air-conditioning Engineers) A Practical Guide to Seismic Restraint
4. MSS (Manufacturers Standardization Society of the Valve and Fittings Industry) MSS SP-127, Bracing for Piping Systems, Seismic – Wind – Dynamic, Design, Selection, Application.

1.6 ISOLATOR AND RESTRAINT MANUFACTURER'S RESPONSIBILITIES:

A. Provide project specific vibration isolation and seismic restraint design prepared by a registered design professional in the state were the project is being constructed, and manufacturer certifications that the components are seismically qualified.

1. Provide calculations to determine restraint loads resulting from seismic forces as required by IBC, Chapter 16 and ASCE 7, latest editions. Seismic calculations shall be certified by an engineer licensed in the state where the project is being constructed.

B. Provide installation instructions and shop drawings for all materials supplied under this section of the specifications.

1. Provide seismic restraint details with specific information relating to the materials, type, size, and locations of anchorages; materials used for bracing; attachment requirements of bracing to structure and component; and locations of transverse and longitudinal sway bracing and rod stiffeners.
2. Provide seismic bracing layout drawings indicating the location of all seismic restraints.

a. Each piece of rotating isolated equipment shall be tagged to clearly identify quantity and size of vibration isolators and seismic restraints.

C. Provide, in writing, the special inspection requirements for all Designated Seismic Systems as indicated in Chapter 17 of the IBC.

D. Provide training for installation, operation and maintenance of isolation and restraint systems.

1.7 PERFORMANCE REQUIREMENTS

A. Flood-Restraint Loading: Per the structural drawings and specifications.

B. Seismic-Restraint Loading:
1. Site Class as Defined in the IBC: Per the structural drawings and specifications.
2. Assigned Occupancy Category as Defined in the IBC: Per the structural drawings and specifications.

a. Component Importance Factor: 1.5.
1) Life safety components required to function after an earthquake.
2) Components containing hazardous or flammable materials in quantities that exceed the exempted amounts for an open system listed in Chapter 4.
3) For structures with an Occupancy Category IV, components needed for continued operation of the facility or whose failure could impair the continued operation of the facility.
4) Storage racks in occupancies open to the general public (e.g., warehouse retail stores).
b. Component Importance Factor: 1.0.
1) All other components
c. Component Response Modification Factor: Per the structural drawings and specifications.
d. Component Amplification Factor: Per the structural drawings and specifications.

3. Design Spectral Response Acceleration at Short Periods: Per the structural drawings and specifications.

4. Design Spectral Response Acceleration at 1-Second Period: Per the structural drawings and specifications.

1.8 ACTION SUBMITTALS

A. Product Data: For the following:

1. Submittals shall include catalog cut sheets and installation instructions for each type of anchor and seismic restraint used on equipment or components being isolated and/or restrained.
2. Submittals for mountings and hangers incorporating springs shall include spring diameter and free height, rated load, rated deflection, and overload capacity for each vibration isolation device.
3. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.

    a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an **evaluation service member of ICC-ES**.
    b. Annotate to indicate application of each product submitted and compliance with requirements.

4. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

B. Shop Drawings:

1. Detail fabrication and assembly of equipment bases. 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 vibration isolation and seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. “Basis for Design” report: Statement from the registered design professional that the design complies with the requirements of the ASCE 7-05 Chapter 13, IBC 2009 chapter 1912 and ACI 318. In addition, the basis for compliance must also be noted, as listed below:

    a. Project specific design documentation prepared and submitted by a registered design professional (ASCE 7, 13.2.1.1)
    b. Submittal of the manufacturer’s certification that the isolation equipment is seismically qualified by:
    c. An engineered analysis conforming to the requirements of Chapter 13 of ASCE 7.
    d. Testing by a nationally recognized testing standard procedure such as ICC-ES AC 156. The substantiated seismic design capacities shall exceed the seismic demands determined by Section 13.3 of ASCE 7.

e. Experience data conforming to a nationally recognized procedure. The substantiated seismic design capacities shall exceed the seismic demands determined by Section 13.3 of ASCE 7.

2. Seismic restraint load ratings must be certified and substantiated by testing or calculations under direct control of a registered professional engineer. Copies of testing and calculations must be submitted as part of submittal documents. OSHPD pre-approved restraint systems are exempt from this requirement if their pre-approval is current and based upon the IBC 2009 (i.e. OPA-07 pre-approval numbers).

3. Include design calculations and details for selecting vibration isolators, seismic restraints, and vibration isolation bases complying with performance requirements, design criteria, and analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

4. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, **seismic** forces required to select vibration isolators, **seismic** restraints, and for designing vibration isolation bases.

   a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Division 23 Sections for equipment mounted outdoors.

5. 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 that riser system has been examined for excessive stress and that none will exist.
6. Vibration Isolation Base Details: Detail overall dimensions, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.
7. **Seismic**-Restraint Details:

   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 the 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. Preapproval and Evaluation Documentation: By **an evaluation service member of ICC-ES**, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

1.9 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show coordination of seismic bracing for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and seismic restraints.

1. Submittal drawings and calculations must be stamped by a registered professional engineer in the State where the project is being constructed who is responsible for the seismic restraint design.
2. Calculations and restraint device submittal drawings shall specify anchor bolt type, embedment, concrete compressive strength, minimum spacing between anchors, and minimum distances of anchors from concrete edges. Concrete anchor locations shall not be near edges, stress joints, or an existing fracture. All bolts shall be ASTM A307 or better.

B. Qualification Data: For professional engineer and testing agency.

C. Welding certificates.

D. Field quality-control test reports.

1.10 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

1.11 SEISMIC CERTIFICATION OF EQUIPMENT

A. Component Importance Factor. All plumbing and mechanical components shall be assigned a component importance factor. The component importance factor, I_p, shall be taken as 1.5 if any of the following conditions apply:

1. The component is required to function for life-safety purposes after an earthquake.
2. The component contains hazardous materials.
3. The component is in or attached to an Occupancy Category IV structure and it is needed for continued operation of the facility or its failure could impair the continued operation of the facility.

B. All other components shall be assigned a component importance factor, I*p*, equal to 1.0.

C. For equipment or components where I*p* = 1.0.

1. Submit manufacturer's certification that the equipment is seismically qualified by:

   a. An engineered analysis conforming to the requirements of Chapter 13 of ASCE 7.
   b. Testing by a nationally recognized testing standard procedure such as ICC-ES AC 156. The substantiated seismic design capacities shall exceed the seismic demands determined by Section 13.3 of ASCE 7.
   c. Experience data conforming to a nationally recognized procedure. The substantiated seismic design capacities shall exceed the seismic demands determined by Section 13.3 of ASCE 7.

2. The equipment and components listed below are considered rugged and shall not require Special Seismic Certification:

   a. Valves (not in cast-iron housings, except for ductile cast iron).
   b. Pneumatic operators.
   c. Hydraulic operators.
   d. Motors and motor operators.
   e. Horizontal and vertical pumps (including vacuum pumps).
   f. Air compressors
   g. Refrigerators and freezers.
   h. Elevator cabs.
   i. Underground tanks.
   j. Equipment and components weighing not more than 20 lbs. supported directly on structures (and not mounted on other equipment or components) with supports and attachments in accordance with Chapter 13, ASCE 7.

3. Rugged equipment and components in this section are for factory assembled discrete equipment and components only and do not apply to site assembled or field assembled equipment or equipment anchorage. The list is based in part on OSHPD Code Application Notice 2-1708A.5.

D. Special Certification requirements for Designated Seismic Systems (i.e. I*p* = 1.5): Seismic Certificates of Compliance supplied by manufacturers shall be submitted for all components that are part of Designated Seismic Systems. In accordance with the ASCE 7, certification shall be via one of the following methods:

1. For active mechanical and electrical equipment that must remain operable following the design earthquake:

a. Testing as detailed by part C.1.b above.
b. Experience data as detailed by part C.1.c above.
c. Equipment that is considered “rugged” per part C.2 above.

2. Components with hazardous contents shall be certified by the manufacturer as maintaining containment following the design earthquake by:

a. Testing as detailed by part C.1.b above.
b. Experience data as detailed by part C.1.c above.
c. Engineering analysis utilizing dynamic characteristics and forces. Tanks (without vibration isolators) designed by a registered design professional in accordance with ASME Boiler and Pressure Vessel Code, and satisfying the force and displacement requirements of Sections 13.3.1 and 13.3.2 of ASCE 7 having an importance factor, I_p = 1.0 shall be considered to satisfy the Special Seismic Certification requirements on the basis of ASCE 7 Section 13.6.9.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

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

1. Amber/Booth Company, Inc.
2. CalDyn (California Dynamics Corporation).
3. ISAT (International Seismic Application Technology).
4. Kinetics Noise Control.
5. Mason Industries.
6. Vibro-Acoustics
7. VMC (Vibration Mountings & Controls, Inc.)

B. Elastomeric Isolation Pads **P1**:

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.
4. Surface Pattern: **Ribbed** pattern.
5. Load-bearing metal plates adhered to pads.

C. Double-Deflection, Elastomeric Isolation Mounts **M1**:

1. Mounting Plates:

a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded, or with threaded studs or bolts.
b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.

2. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

D. Restrained Elastomeric Isolation Mounts **M2**:

1. 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.

E. Spring Isolators **S1**: Freestanding, laterally stable, open-spring isolators.

1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch-thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig.
6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

F. Restrained Spring Isolators **S2**: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.

1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch-thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation. Baseplates shall limit floor load to 500 psig.
2. Restraint: Seismic or limit stop as required for equipment and authorities having jurisdiction.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

G. Housed Restrained Spring Isolators **S3**: Freestanding, Steel, Open-Spring Isolators with Vertical-Limit Stop Restraint in Two-Part Telescoping Housing:

1. 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 shall limit floor load to 500 psig.
    b. Threaded top housing with adjustment bolt and cap screw to fasten and level equipment.

2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric pad: For high frequency absorption at the base of the spring.

H. Elastomeric Hangers **H1**:

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

    a. 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.
    b. Dampening Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

I. Spring Hangers **H2**: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.

1. Description: Combination Coil-Spring and Elastomeric-Insert Hanger with spring and Insert in Compression.
    a. 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.
    b. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
    c. Minimum Additional Travel: 50 percent of the required deflection at rated load.
    d. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
    e. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

f. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
g. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

J. Spring Hangers with Vertical-Limit Stop **H3**: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.

1. Description: Combination Coil-Spring and Elastomeric-Insert Hanger with spring and insert in Compression and vertical limit stop.

a. 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.
b. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
c. Minimum Additional Travel: 50 percent of the required deflection at rated load.
d. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
e. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
f. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
g. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
h. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

K. Pipe Riser Resilient Support **R1**:

1. Description: All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 1/2-inch-thick neoprene.

a. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
b. Maximum Load Per Support: 500 psig on isolation material providing equal isolation in all directions.

L. Resilient Pipe Guides **R2**:

1. Description: Telescopic arrangement of two steel tubes or post and sleeve arrangement separated by a minimum 1/2-inch-thick neoprene.

a. Factory-Set Height Guide with Shear Pin: Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

M. Horizontal Thrust Restraints **T1**: Modified specification S2 isolator.

1. Horizontal thrust restraints shall consist of a modified specification S2 spring mounting. Restraint springs shall have the same deflection as the isolator springs.
2. The assembly shall be preset at the factory and fine tuned in the field to allow for a maximum of 1/4" movement from stop to maximum thrust.
3. The assemblies shall be furnished with rod and angle brackets for attachment to both the equipment and duct work or the equipment and the structure.
4. Restraints shall be attached at the center line of thrust and symmetrically on both sides of the unit.

2.2 RESTRAINED VIBRATION ISOLATION ROOF-CURB RAILS

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

1. Amber/Booth Company, Inc.
2. CalDyn (California Dynamics Corporation).
3. ISAT (International Seismic Application Technology).
4. Kinetics Noise Control.
5. Mason Industries.
6. Vibro-Acoustics
7. VMC (Vibration Mountings & Controls, Inc.)

B. Restrained Vibration Isolation Roof-Curb Rails: **RC1**:

C. Description: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment and to withstand seismic and wind forces.

D. Upper Frame: The upper frame shall provide continuous support for equipment and shall be captive to resiliently resist **seismic** forces.

E. Lower Support Assembly: The lower support assembly shall be a formed sheet-metal section containing adjustable and removable steel springs that support upper frame. Lower support assembly shall have a means for attaching to building structure and a wood nailer for attaching roof materials, and shall be insulated with a minimum of 2 inches of rigid, glass-fiber insulation on inside of assembly.

F. Spring Isolators: Adjustable, restrained spring isolators shall be mounted on 1/4-inch-thick, elastomeric vibration isolation pads and shall have access ports, for level adjustment, with removable waterproof covers at all isolator locations. Isolators shall be located so they are accessible for adjustment at any time during the life of the installation without interfering with the integrity of the roof.

1. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic and wind restraint.

   a. Housing: Steel with resilient vertical-limit stops and adjustable equipment mounting and leveling bolt.

b. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
c. Minimum Additional Travel: 50 percent of the required deflection at rated load.
d. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
e. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

G. Snubber Bushings: All-directional, elastomeric snubber bushings at least 1/4 inch-thick.

H. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counterflashed over roof materials.

2.3 VIBRATION ISOLATION EQUIPMENT BASES

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

1. Amber/Booth Company, Inc.
2. CalDyn (California Dynamics Corporation).
3. ISAT (International Seismic Application Technology).
4. Kinetics Noise Control.
5. Mason Industries.
6. Vibro-Acoustics
7. VMC (Vibration Mountings & Controls, Inc.)

B. Steel Bases and Rails **SB1**: 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 A 36/A 36M. Bases shall 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. Inertia Base **IB1**: Factory-fabricated, welded, structural-steel bases and rails ready for placement of cast-in-place concrete.

1. Design Requirements: Lowest possible mounting height with not less than **[1-inch] 2-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 A 36/A 36M. Bases shall 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.

2.4 SEISMIC-RESTRAINT DEVICES

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

1. Amber/Booth Company, Inc.
2. CalDyn (California Dynamics Corporation).
3. ISAT (International Seismic Application Technology).
4. Kinetics Noise Control.
5. Mason Industries.
6. Vibro-Acoustics
7. VMC (Vibration Mountings & Controls, Inc.)

B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by **an evaluation service member of ICC-ES**.

1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

C. Snubbers: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.

1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
2. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
3. Maximum 1/4-inch air gap, and minimum 1/4-inch-thick resilient cushion.

D. Channel Support System: MFMA-4, shop- or field-fabricated support assembly made of slotted steel channels with 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; and rated in tension, compression, and torsion forces.

E. Restraint Cables: ASTM A 603 galvanized or ASTM A 492 stainless-steel cables with end connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement. Cables located in exterior or other wet locations such as wash-down areas shall be stainless steel.

F. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or reinforcing steel angle clamped to hanger rod.

G. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.

H. 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.

I. 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.

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

K. Mechanical Anchor Bolts: 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 required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.

L. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing polyvinyl 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 E 488.

M. All post installed anchors utilized in the seismic design must be qualified for use in cracked concrete and approved for use with seismic loads.

N. Expansion anchors shall not be used for anchorage of equipment with motors rated over 10 HP with the exception of undercut expansion anchors. Spring or internally isolated equipment are exempt from this requirement.

O. All beam clamps utilized for vertical support must also incorporate retention straps.

P. All seismic brace arm anchorages to include concrete anchors, beam clamps, truss connections, etc., must be approved for use with seismic loads.

2.5 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and tested equipment before shipping.

1. Powder coating on springs and housings.
2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
3. Baked enamel or powder coat for metal components on isolators for interior use.

4. Color-code or otherwise mark vibration isolation and **seismic** control devices to indicate capacity range.

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 COORDINATION

A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in **Divison 03 Section "Cast-in-Place Concrete**."

B. Coordinate size, shape, reinforcement and attachment of all housekeeping pads supporting vibration/seismically rated equipment. Concrete shall have a minimum compressive strength of 4,000 psi or as specified by the project engineer. Coordinate size, thickness, doweling, and reinforcing of concrete equipment housekeeping pads and piers with vibration isolation and seismic restraint device manufacturer to ensure adequate space, embedment and prevent edge breakout failures. Pads and piers must be adequately doweled in to structural slab.

C. Housekeeping pads shall have adequate space to mount equipment and seismic restraint devices.

D. Housekeeping Pads must be adequately reinforced and adequately sized for proper installation of equipment anchors and shall also be large enough and thick enough to ensure adequate edge distance and embedment depth for restraint anchor bolts to avoid housekeeping pad breakout failure. Refer seismic restraint manufacturer’s written instructions.

E. Coordinate with vibration/seismic restraint manufacturer and the structural engineer of record to locate and size structural supports underneath vibration/seismically restrained equipment (e.g. roof curbs, cooling towers and other similar equipment). Installation of all seismic restraint materials specified in this section shall be accomplished as per the manufacturer’s written instructions. Adjust isolators and restraints after piping systems have been filled and equipment is at its operating weight, following the manufacturer’s written instructions.

3.3 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by **an evaluation service member of ICC-ES** and per the seismic restraint manufacturer's design.

B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.4 VIBRATION-CONTROL DEVICE INSTALLATION

A. Comply with requirements in Division 07 Section "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.

B. Comply with requirements in Division 23 Section "Hydronic Piping" for piping flexible connections.

C. Isolate all mechanical equipment 0.75 hp and over per the isolator and seismic restraint schedule and these specifications. Vibration isolators shall be selected in accordance with the equipment, pipe or duct weight distribution so as to produce reasonably uniform deflections

D. All isolation materials and seismic restraints shall be of the same vendor and shall be selected and certified using published or factory certified data

E. Installation of all vibration isolation materials, flexible connectors and supplemental equipment bases specified in this section shall be accomplished as per the manufacturer's written instructions with mountings adjusted to level equipment. Any variance or non-compliance with the manufacturer's instructions shall be reviewed and approved in writing by the manufacturer or corrected by the contractor in an approved manner.

F. Installation of vibration isolators must not cause any change of position of equipment, piping or duct work resulting in stresses or misalignment.

G. Locate isolation hangers as near to the overhead support structure as possible.

H. No rigid connections between isolated components and the building structure shall be made that degrades the noise and vibration control system herein specified. "Building" includes, but is not limited to, slabs, beams, columns, studs and walls. "Components" includes, but is not limited to, mechanical equipment, piping and ducts.

I. Coordinate work with other trades to avoid rigid contact with the building.

J. Any conflicts with other trades which will result in rigid contact with equipment or piping due to inadequate space or other unforeseen conditions should be brought to the architects/engineers attention prior to installation. Corrective work necessitated by conflicts after installation shall be at the responsible contractor's expense.

K. Bring to the architects/engineers attention any discrepancies between the specifications and the field conditions or changes required due to specific equipment selection, prior to installation. Corrective work necessitated by discrepancies after installation shall be at the responsible contractor's expense.

L. Correct, at no additional cost, all installations which are deemed defective in workmanship and materials at the contractor's expense.

M. Use horizontal thrust restraints **T1** to protect Air handling equipment and centrifugal fans against excessive displacement which results from high air thrust when thrust forces exceed 10% of the equipment weight.

N. Isolated equipment, duct and piping located on roofs must be attached to the structure. Supports (e.g., sleepers) that are not attached to the structure will not be acceptable.

O. On completion of installation of all isolation materials and before startup of isolated equipment all debris shall be cleared from areas surrounding and from beneath all isolated equipment, leaving equipment free to move on the isolation supports.

P. All floor mounted isolated equipment shall be protected with specification M1, M2, S1, S2 or S3 isolator.

Q. Horizontal Pipe Isolation: All HVAC pumped water, pumped condensate, glycol, and refrigerant piping size 1-1/4" and larger within mechanical rooms shall be isolated. Outside equipment rooms this piping shall be isolated for the greater of 50' or 100 pipe diameters from rotating equipment. For the first three (3) support locations from externally isolated equipment provide specification H2 or H3 hangers or specification S1, S2 or S3 mounts with the same deflection as equipment isolators (max 2"). All other piping within the equipment rooms shall be isolated with the same specification isolators with a 3/4" minimum deflection. Steam piping size 1-1/4" and larger which is within an equipment room and connected to rotating equipment shall be isolated for three (3) support locations from the equipment. Provide specification H2 or H3 hangers, or specification S1 or S2 mounts with the same deflection as equipment isolators but a minimum of ¾".

R. Install full line size flexible pipe connectors at the inlet and outlet of each pump, cooling tower, condenser, chiller, coiling connections and where shown on the drawings. All connectors shall be suitable for use at the temperature, pressure, and service encountered at the point of installation and operation. End fitting connectors shall conform to the pipefitting schedule. Control rods or protective braid must be used to limit elongation to 3/8". Flexible connectors shall not be required for suspended in-line pumps.

S. All plumbing pumped water, piping size 1-1/4" and larger within mechanical rooms shall be isolated the same as HVAC piping above. Isolators are not required for any plumbing pumped

T. Pipe Riser Isolation: The operating weight of all variable temperature vertical pipe risers 1-1/4" and larger, requiring isolation where specifically shown and detailed on riser drawings shall be fully supported by specification M1, M2 or R1 supports. S1, S2, S3, H2 or H3 steel spring deflection isolators with minimum 3/4-inch minimum shall be in those locations where added deflection is required due to pipe expansion and contraction. Spring deflection shall be a minimum of 4 times the anticipated deflection change. Springs shall be selected to keep the riser in tension. Height saving brackets used with isolators having 2.5" deflection or greater shall be of the precompression type to limit exposed bolt length. Specification R1 riser supports shall be installed near the center point of the riser to anchor the riser when spring isolation is used. Specification R2 riser guides may be used in conjunction with spring isolators per design calculations. Pipe risers up through 16" shall be supported at intervals of every third floor of the building. Pipe risers 18" and over, every second floor. Wall sleeves for take-offs from riser shall be sized for insulation O.D. plus two times the anticipated movement to prevent binding. Horizontal take-offs and at upper and lower elbows shall be supported with spring isolators as required to accommodate anticipated movement. In addition to submittal data requirements previously outlined, riser diagrams and calculations shall be submitted for approval. Calculations must show anticipated expansion and contraction at each support point, initial and final loads on the building structure, and spring deflection changes. Submittal data shall include certification that the riser system has been examined for excessive stresses and that none will exist if installed per design proposed.

U. Where riser pipes pass through cored holes, core diameters shall be a maximum of 2" larger than pipe O.D. including insulation. Cored holes must be packed with resilient material or firestop as provided by other sections of this specification or local codes. Where seismic restraint is required specification isolator S3 shall support risers and provide longitudinal restraint at floors where thermal expansion is minimal and will not bind isolator restraints.

V. Duct Isolation: Isolate all duct work with a static pressure 2" W.C. and over in equipment rooms and to minimum of 50 feet from the fan or air handler. Use specification type H2 or H3 hangers or type S1 or S2 floor mounts.

3.5 SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Equipment Restraints:

1. On projects with Seismic Site Class A or B, seismic design or restraint is not required.

2. On projects with Seismic Design Category C: Components with an importance factor of 1.0 do not require seismic design or restraint.

3. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.

4. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.

5. Install seismic-restraint devices using methods approved by **an evaluation service member of ICC-ES** providing required submittals for component.

6. Suspended Equipment: All suspended equipment that meets any of the following conditions requires seismic restraints as specified by the supplier:

   a. Rigidly attached to pipe or duct that is 75 lbs. and greater,
   b. Items greater than 20 lbs and distribution systems weighing more than 5 lbs/lineal foot, with an importance factor of 1.0 hung independently or with flexible connections.
   c. Possibility of consequential damage.
   d. For importance factors greater than 1.0 all suspended equipment requires seismic restraint regardless of the above notes.
   e. Wall mounted equipment weighing more than 20 lbs.
   f. Exemptions:

      1) Equipment weighing less than 20 lbs and distribution systems weighing less than 5 lbs/lineal foot, with an Ip = 1.0 and where flexible connections exist between the component and associated ductwork, piping or conduit.

7. Base Mounted Equipment: All base mounted equipment that meets any of the following conditions requires attachments and seismic restraints as specified by the supplier:

   a. Connections to or containing hazardous material,
   b. With an overturning moment.
   c. Weight greater than 400 lbs.
   d. Mounted on a stand 4 ft. or more from the floor
   e. Possibility of consequential damage.
   f. For importance factors greater than 1.0 all base mounted items require seismic restraints regardless of the above notes.
   g. For equipment with high center of gravity additional cable restraints shall be furnished, as required by isolation manufacturer, to limit forces and motion caused by rocking.
   h. Exemptions:

      1) Floor or curb-mounted equipment weighing less than 400 lbs and not resiliently mounted, where the Importance Factor, Ip = 1.0, the components are mounted at 4 feet or less above a floor level, flexible connections between the components and associated duct work, piping and conduit are provided and there is no possibility of consequential damage.

8. Roof Mounted Equipment:
   a. To be installed on a structural frame, seismically rated roof curb, or structural curb frame mechanically connected to the structure. Items shall not be mounted onto

sleepers or pads that are not mechanically and rigidly attached to the structure. Restraint must be adequate to resist both seismic and wind forces.

b. Roof curbs shall be installed directly to building structural steel or concrete roof deck and not to top of steel deck or roofing material.

c. Exemptions:

1) Curb-mounted mushroom, exhaust and vent fans with curb area less than nine square feet are excluded.

9. Rigid Mounted Equipment:

a. Anchor floor and wall mounted equipment to the structure as per the stamped seismic certifications / drawings.

b. For equipment with high center of gravity additional cable restraints shall be furnished, as required by isolation manufacturer, to limit forces and motion caused by rocking.

c. Suspended equipment shall be restrained using seismic cable restraints, or struts, and hanger rods as per the stamped seismic certifications / drawings.

10. Vibration Isolated Equipment:

a. Seismic control shall not compromise the performance of noise control, vibration isolation or fire stopping systems.

b. Equipment supported by vibration-isolation hangers shall be detailed and installed with approximately a 1/8” gap between the isolation hangers and the structure. Isolators at restraint locations must be fitted with uplift limit stops.

B. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.

C. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.

D. Install seismic-restraint devices using methods approved by **an evaluation service member of ICC-ES** providing required submittals for component.

E. Installation and adjustment of all seismic restraints specified in this section shall be accomplished as per the manufacturer’s written instructions. Any deviation from the manufacturer’s instructions shall be reviewed and approved by the manufacturer.

F. Piping Restraints:

1. Comply with requirements in MSS SP-127.
4. Seismically restrain piping, with an Ip = 1.0, located in boiler rooms, mechanical equipment rooms and refrigeration equipment rooms that is 1¼” I.D. and larger.
5. Seismically restrain all other Ip = 1.0 piping 2½” diameter and larger.
6. Seismically restrain all Ip = 1.5 piping larger than 1” diameter.
7. Branch lines may not be used to brace main lines.
8. Exemptions:

a. All high deformability pipe 3” or less in diameter suspended by individual hanger rods where Ip = 1.0.
b. High deformability pipe or conduit in Seismic Design Category C, 2” or less in diameter suspended by individual hanger rods where Ip = 1.5.
c. High deformability pipe in Seismic Design Category D, E or F, 1” or less in diameter suspended by individual hanger rods where Ip = 1.5.
d. All clevis supported pipe runs installed less than 12” from the top of the pipe to the underside of the support point and trapeze supported pipe suspended by hanger rods having a distance less than 12” in length from the underside of the pipe support to the support point of the structure.
e. Piping systems, including their supports, designed and constructed in accordance with ASME B31.
f. Piping systems, including their supports, designed and constructed in accordance with NFPA, provided they meet the force and displacement requirements of Section 13.3.1 and 13.3.2 (ASCE 7).

G. Install flexible metal hose loops in piping which crosses building seismic joints, sized for the anticipated amount of movement.

H. Install flexible piping connectors 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.

I. Where pipe sizes reduce below dimensions required for seismic, the final restraint shall be installed at the transition location.

J. Restraint Spacing For Piping: Sizes shown are maximum. Actual spacing determined by calculation.

1. For non-ductile piping (e.g., cast iron, PVC) space transverse supports a maximum of 20’ o.c., and longitudinal supports a maximum of 40’ o.c.
2. For piping with hazardous material inside (e.g., natural gas, medical gas) space Transverse supports a maximum of 20’ o.c., and longitudinal supports a maximum of 40’ o.c.
3. For pipe risers, restrain the piping at floor penetrations using the same spacing requirements as above.
4. For all other ductile piping see Table “A” below

K. Seismic Restraint of Ductwork: Seismically restrain per specific code requirements, all ductwork listed below (unless otherwise indicated on the drawings), using seismic cable restraints: (Ductwork not meeting criteria listed below is to be “Exempt”)

1. Restrain rectangular ductwork with cross sectional area of 6 square feet or larger. Duct with and an importance factor of 1.5 must be braced with no exceptions regardless of size or distance requirements.
2. Restrain round ducts with diameters of 28” or larger. Duct with an importance factor of 1.5 must be braced with no exceptions regardless of size or distance requirements.

3. Restrain flat oval ducts the same as rectangular ducts of the same nominal size.
4. Duct must be reinforced at the restraint locations. Reinforcement shall consist of an additional angle on top of the ductwork that is attached to the support hanger rods. Ductwork is to be attached to both upper angle and lower trapeze. Additional reinforcing is not required if duct sections are mechanically fastened together with frame bolts and positively fastened to the duct support suspension system.
5. A group of ducts may be combined in a larger frame so that the combined weights and dimensions of the ducts are less than or equal to the maximum weight and dimensions of the duct for which bracing details are selected.
6. Walls, including gypsum board non-bearing partitions, which have ducts running through them, may replace a typical transverse brace. Provide channel framing around ducts and solid blocking between the duct and frame.
7. If ducts are supported by angles, channels or struts, ducts shall be fastened to it at seismic brace locations in lieu of duct reinforcement.
8. All ductwork weighing more than 17 lb/ft.
9. Exemptions:

    a. Duct runs supported at locations by two rods less than 12 inches in length from the structural support to the structural connection to the ductwork. This exemption does not apply to ducts with an importance factor of 1.5.

10. See Table “A” below for restraint spacing.

L. Exemptions do not apply for:

1. Life Safety or High Hazard Components

    a. Including gas, fire protection, medical gas, fuel oil and compressed air needed for the continued operation of the facility or whose failure could impair the facility’s continued operation, Occupancy Category IV, IBC-2009 as listed in Section 1.3 B regardless of governing code for HVAC, Plumbing, Electrical piping or equipment. (A partial list is illustrated.) High Hazard is additionally classified as any system handling flammable, combustible or toxic material. Typical systems not excluded are additionally listed below.

2. Piping

    a. Fuel oil, gasoline, natural gas, medical gas, steam, compressed air or any piping containing hazardous, flammable, combustible, toxic or corrosive materials. Fire protection standpipe, risers and mains. Fire Sprinkler Branch Lines must be end tied.

3. Duct

    a. Smoke evacuation duct or fresh air make up connected to emergency system, emergency generator exhaust, boiler breeching or as used by the fire department on manual override.

4. Equipment

   a. Previously excluded non life safety duct mounted systems such as fans, variable air volume boxes, heat exchangers and humidifiers having a weight greater than 75 lbs require independent seismic bracing.

M. Spacing Chart For Suspended Components:

Table "A" Seismic Bracing (Maximum Allowable Spacing Shown- Actual Spacing to Be Determined by Calculation)			
Equipment	**On Center Trans-verse**	**On Center Longitu-dinal**	**Change Of Direction**
Duct			
All Sizes	30 Feet	60 Feet	4 Feet
Pipe Threaded, Welded, Soldered Or Grooved			
To 16"	40 Feet	80 Feet	4 Feet
18" – 28"	30 Feet	60 Feet	4 Feet
30" – 40"	20 Feet	60 Feet	4 Feet
42" & Larger	10 Feet	30 Feet	4 Feet

N. Roof mounted duct is to be installed on sleepers or frames mechanically connected to the building structure. Roof anchors and seismic cables or frames shall be used to resist seismic and wind loading. Wind loading factors shall be determined by the registered design professional.

O. Where duct sizes reduce below dimensions required for seismic restraint the final restraint shall be installed at the transition location.

P. Install cables so they do not bend across edges of adjacent equipment or building structure.

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

R. 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.

S. 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.

T. Seismically Rated Beam Clamps are required where welding to or penetrations to steel beams are not approved.

U. Drilled-in 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. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive Anchors: 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.

3.6 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in piping where they cross seismic joints, 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 Division 23 Section "Hydronic Piping" for piping flexible connections.

3.7 FIELD QUFALITY CONTROL

A. Testing Agency: Engag**e** a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

1. A representative of the vibration isolation system manufacturer shall review the project installation and provide documentation indicating conformance to vibration isolation design intent

C. Remove and replace malfunctioning units and retest as specified above.

D. Prepare test and inspection reports.

1. The installing contractor shall submit a report upon request to the building architect and/or engineer, including the manufacturer’s representative’s final report, indicating that all seismic restraint material has been properly installed, or steps that are to be taken by the contractor to properly complete the seismic restraint work as per the specifications.

3.8 IDENTIFICATION

A. Install identification tags at all seismic brace locations. Tags to include the following information:

1. Specific seismic forces (g-force) the location was designed to resist.
2. Maximum brace reaction at connection to structure.
3. For single hung items, the maximum pipe/conduit size the brace location was designed to accommodate.
4. For trapeze supported items, the maximum weight (lbs/lf) the brace location was designed to accommodate.
5. For suspended equipment, the maximum unit operating weight (lbs) the brace location was designed to accommodate.
6. Location identifier cross matched to that on plan set layout.
7. Company name of installing contractor.

3.9 ADJUSTING

A. Adjust isolators after piping system is at operating weight.

B. Adjust leveling devices as required to distribute loading uniformly on isolators. Shim units as required where leveling devices cannot be used to distribute loading properly.
   1. Adjust active height of spring isolators.

C. 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.

D. Adjust restraints to permit free movement of equipment within normal mode of operation.

EQUIPMENT ISOLATION SCHEDULE

LOCATION	A' CRITICAL (35'-50' SPAN)			B' UPPER STORY (20'-35' SPAN)			C' GRADE		
EQUIPMENT (1)	ISOLATOR TYPE	MINIMUM DEFLECTION (IN)	BASE TYPE	ISOLATOR TYPE	MINIMUM DEFLECTION (IN)	BASE TYPE	ISOLATOR TYPE	MINIMUM DEFLECTION (IN)	BASE TYPE
AIR HANDLING UNITS									
FLOOR MOUNTED									
UP TO 15 HP	S3	1.5		S3	0.75		S3	0.75	
20 HP & OVER	S3	2.5	SB1	S3	1.5		S3	0.75	
SUSPENDED									
UP TO 15 HP	H3	1.75		H3	1		H3	1	
20 HP & OVER	H3	2.5	SB1	H3	1.75		H3	1	
HIGH PRESSURE FAN SECTIONS									
UP TO 30 HP	S1	2.5	IB1	S3	1.5	IB1	S3	0.75	IB1
40 HP & OVER	S1	3.5	IB1	S3	2.5	IB1	S3	1.5	IB1
CENTRIFUGAL FANS									
CL. I & II UP TO *54-112"* W.D.									
UPT015HP	S3	1.5	SB1	S3	0.75	SB1	S3	0.75	SB1

20-50 HP	S1	2.5	IB1	S3	1.5	IB1	S3	0.75	SB1
60 HP & OVER	S1	3.5	IB1	S1	2.5	IB1	S3	1.5	SB1
CL. I & II 60" W.D. & OVERI ALL CL. III FANS									
UPT015HP	S1	2.5	IB1	S3	1.5	IB1	S3	0.75	IB1
20-50 H P	S1	2.5	IB1	S1	2.5	IB1	S3	1.5	IB1
60 HP & OVER	S1	3.5	IB1	S1	2.5	IB1	S3	1.5	IB1
AXIAL FLOWFANS									
FLOOR MTD.									
UP TO 15 HP	S3	1.5	SB1	S3	0.75		S3	0.75	
20 HP & OVER	S1	3.5	IB1	S3	1.5		S3	0.75	
SUSPENDED									
UP TO 15 HP	H3	1.75	SB1	H3	1		H3	1	
20 HP & OVER	H3	2.5	SB1	H3	1.75	SB1	H3	1.5	
VENT (UTILITY SETS)									
FLOOR MTD	S3	1.5	SB1	S3	0.75		S3	0.75	
SUSPENDED	H3	1.75	SB1	H3	1		H3	0.75	
CABINET FANS, FANS SECTIONS									
FLOOR MTD.									
UP TO 15 HP	S3	1.5		S3	0.75		S3	0.75	
20 HP & OVER	S1	2.5	IB1	S3	1.5		S3	0.75	
SUSPENDED									
UP TO 15 HP	H3	1.75		H3	1		H3	0.75	
20 HP & OVER	H3	2.5	SB1	H3	1.75		H3	1.75	
PUMPS									
FLOOR MTD.									
UP TO 15 HP	S3	0.75	IB1	S3	0.75	IB1	SRVD	0.4	IB1
7-112 HP & OVER	S3	1.5	IB1	S3	1.5	IB1	S3	0.75	IB1
SUSPENDED INLINE	H3	1.75		H3	1.75		H3	1	
REFRIGERATION UNITS									
RECIPROCATING COMPRESSORS	S1	2.5	IB1	S3	1.5	IB1	S3	0.75	IB1
RECIPROCATING CONDo UNITS & CHILLERS	S1	2.5	IB1	S3	1.5		S3	0.75	
HERMETIC CENTRIFUGALS	S3	2.5		S3	1.5		P1	0.15	
OPEN CENTRIFUGALS	S1	2.5	IB1	S3	1.5	IB1	P1	0.15	
ABSORPTION MACHINES	S3	1.5		S3	0.75		P1	0.15	
AIR COMPRESSORS									
TANK TYPE (HORIZONTAL TANK)	S1	2.5	IB1	S3	1.5		S3	0.75	
TANK TYPE (VERTICAL TANK)	S1	2.5	IB1	S3	1.5	IB1	S3	0.75	
COOLING TOWERS & CLOSED CIRCUIT COOLERS									
UP TO 500 TONS	S3	2.5		S3	0.75		P1	0.15	
OVER 500 TONS	S3	4.5		S3	2.5		P1	0.15	
AIR COOLED CONDENSERS									
UP TO 50 TONS	S3	1.5		S3	0.75		P1	0.15	
OVER 50 TONS	S3	2.5		S3	1.5		P1	0.15	
ROOFTOP AIR CONDITIONING UNITS									
REQUIRING WEATHER SEAL									
UP TO 5000 CFM (12 TON)	S1	1.5	RC1	S1	0.75	RC1			
OVER 5000 CFM (12 TON)	S3	2.5	RC1	S3	1.5	RC1			
OTHER TYPES									
UP TO 25 TONS	S3	1.5		S3	1.5				
OVER 25 TONS	S3	2.5		S3	1.5				
BOILER (PACKAGE TYPE)									
ALL SIZES	S3	1.5		S3	0.75		P1	0.15	
ENGINE DRIVEN GENERATORS									
UP TO 60 HP	S1	2.5	IB1	S3	1.5	IB1	S3	0.75	
75 HP & OVER	S1	3.5	IB1	S3	2.5	IB1	S3	0.75	

NOTES:

1) Thrust restraints required on all high-pressure fan section, suspended axial-flow fans and on floor-mounted axial fans operating at 3.0” S.P. or greater.

END OF SECTION 230548

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SECTION 230550 - OPERATION AND MAINTENANCE OF HVAC SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. All pertinent sections of Division 21, 22, & 23 Mechanical General Requirements, are part of the work of this Section. Division 1 is part of this and all other sections of these specifications.

1. Testing and Balancing is specified in section 230594.
2. Training and Instructions to Owner's Representative is specified in section 230100.

1.2 SCOPE OF WORK

A. Submission of Operating and Maintenance Manuals complete with Balancing reports. (Coordinate with Division 1).

B. Coordination of work required for system commissioning.

C. Provide a hard copy and an electronic copy of the O and M manual fully searchable in PDF format.

1.3 SUBMITTALS

A. Submit product data in accordance with Division 1 and Section 230100. Submit the following:

1. Sample of O and M manual outline.

PART 2 - PRODUCTS

2.1 O & M MANUALS

A. The operating and maintenance manuals shall be as follows:

1. Binders shall be red buckram with easy-view metal for size 8-1/2 x 11-inch sheets, with capacity expandable from 2 inches to 3-1/2 inches as required for the project. Construction shall be rivet-through with library corners. No. 12 backbone and lining shall be the same material as the cover. The front cover and backbone shall be foil-stamped in white as follows: (coordinate with **Division 01**)

OPERATING AND MAINTENANCE
MANUAL

FOR THE

(INSERT PROJECT NAME)

(INSERT PROJECT COMPLETION YEAR)

VOLUME No. ( )

VAN BOERUM & FRANK ASSOCIATES, INC.
MECHANICAL ENGINEER

(INSERT ARCHITECT)

Binders shall be a manufactured by:

We R Memory Makers
Attn: Melvin Hiller
631 North 400 West
Salt Lake City, Utah 84103
801-539-5000

PART 3 - EXECUTION

3.1 OPERATING AND MAINTENANCE MANUALS:

A. Work under this section shall be performed in concert with the contractor performing the system testing and balancing. Six (6) copies of the manuals shall be furnished to the Architect for distribution to the owner.

B. The "Start-Up and Operation" section is one of the most important in the manual. Information in this section shall be complete and accurately written and shall be verified with the actual equipment on the job, such as switches, starters, relays, automatic controls, etc. A step-by-step start-up procedure shall be described.

C. The manuals shall include water-balancing reports, system commissioning procedures, start-up tests and reports, equipment and system performance test reports, warranties, and certificates of training given to the owner’s representatives.

An index sheet typed on AICO Gold-Line indexes shall be provided in the front of the binder. The manual shall be include the following:

SYSTEM DESCRIPTIONS

START-UP PROCEDURE AND OPERATION OF SYSTEM

MAINTENANCE AND LUBRICATION TABLE

OPERATION AND MAINTENANCE BULLETINS

AUTOMATIC TEMPERATURE CONTROL DESCRIPTION OF OPERATION, INTERLOCK AND CONTROL DIAGRAMS, AND CONTROL PANELS.

AIR AND WATER SYSTEM BALANCING REPORTS

EQUIPMENT WARRANTIES AND TRAINING CERTIFICATES

SYSTEM COMMISSIONING REPORTS

EQUIPMENT START-UP CERTIFICATES

END OF SECTION 230550

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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. Danger, Warning and Caution signs and labels.
3. Pipe labels.
4. Duct labels.
5. Stencils.
6. Valve tags.
7. Danger tags.
8. Warning tags.
9. Caution 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 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. Metal Labels for Equipment:

1. Material and Minimum Thickness, predrilled or stamped holes for attachment hardware:
   a. Brass, 0.032-inch .
2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
4. Fasteners: Stainless-steel;
   a. Rivets.
5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, and having predrilled holes for attachment hardware, 1/16 inch thick.

2. Letter Color:
   a. Black.
3. Background Color:
   a. White.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless-steel;
   a. Rivets.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

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

D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 DANGER, WARNING AND CAUTION SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, having predrilled holes for attachment hardware; 1/16 inch thick.

B. Danger signs, colors:
   1. Letter Color:
      a. White.
   2. Background Color:
      a. Red.

C. Warning signs, colors:
   1. Letter Color:
      a. Black.
   2. Background Color:
      a. Orange.

D. Caution signs, colors:
   1. Letter Color:
      a. Black.
   2. Background Color:
      a. Yellow.

E. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

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

G. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

H. Fasteners: Stainless-steel;
   1. Rivets.

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

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

2.3 PIPE LABELS

A. 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 partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.

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

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: At least 1-1/2 incheshigh.

2.4 DUCT LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, having predrilled holes for attachment hardware; 1/16 inch thick.

B. Letter Color:
1. [Black] .

C. Background Color:
1. [Black] .

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless-steel;
1. [Rivets or self-tapping screws] [Self-tapping screws].

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

I. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions, or as separate unit on each duct label to indicate flow direction.
2. Lettering Size: At least 1-1/2 inches high.

2.5 STENCILS

A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; minimum letter height of 1-1/4 inches for ducts; and minimum letter height of 3/4 inch for access panel and door labels, equipment labels, and similar operational instructions.

1. Stencil Material:
   a. Aluminum .
2. Stencil Paint:
   a. Exterior, gloss, alkyd enamel black unless otherwise indicated.
   b. Paint may be in pressurized spray-can form.
3. Identification Paint:
   a. Exterior, alkyd enamel in colors according to ASME A13.1 unless otherwise indicated.

2.6 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, predrilled or stamped holes for attachment hardware, minimum thickness:
   a. Brass, 0.032-inch
2. Fasteners: Brass;
   a. Wire-link or beaded chain; or S-hook

B. Valve Schedules:

1. For each piping system, on 8-1/2-by-11-inch bond paper, tabulate;
   a. Valve number.
   b. Piping system.
   c. System abbreviation (as shown on valve tag).
   d. Location of valve (room or space).
   e. Normal-operating position (open, closed, or modulating).
   f. Variations for identification.
   g. Mark valves for emergency shutoff and similar special uses.

2. Valve-tag schedule:
   a. Shall be included in operation and maintenance data.

2.7 DANGER TAGS

A. Danger Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.

1. Size:
   a. 3 by 5-1/4 inches minimum
2. Fasteners:
   a. Brass grommet and wire.
3. Nomenclature: Large-size primary caption such as "DANGER," and "DO NOT OPERATE."
4. Color: Red background with white lettering.

2.8 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.

1. Size:
   a. 3 by 5-1/4 inches minimum
2. Fasteners:
   a. Brass grommet and wire.
3. Nomenclature: Large-size primary caption such as “WARNING” and "DO NOT OPERATE."
4. Color: Yellow background with black lettering.

2.9 CAUTION TAGS

A. Caution Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.

1. Size:
   a. 3 by 5-1/4 inches minimum
2. Fasteners:
   a. Brass grommet and wire.
3. Nomenclature: Large-size primary caption such as "CAUTION," and "DO NOT OPERATE."
4. Color: Orange 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. Piping Color-Coding: Painting of piping is specified in Division 09.

B. Stenciled Pipe Label Option:

1. Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option.
2. Install stenciled pipe labels with painted, color-coded bands or rectangles on each piping system.
   a. Identification Paint: Use for contrasting background.
   b. Stencil Paint: Use for pipe marking.

C. 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.

D. Pipe Label Color Schedule: (See Drawing Schedules)

3.4 DUCT LABEL INSTALLATION

A. Install plastic-laminated duct labels with permanent adhesive on air ducts in the following color codes:

1. Blue : For cold-air supply ducts.
2. Yellow : For hot-air supply ducts.
3. Green : For exhaust-, outside-, relief-, return-, and mixed-air ducts.
4. ASME A13.1 Colors and Designs: For hazardous material exhaust.

B. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.5 VALVE-TAG INSTALLATION (See Drawing Schedules.)

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

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

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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. Balancing Air Systems:

   a. Constant-volume air systems.
   b. Variable-air-volume systems.

2. Balancing Hydronic Piping Systems:

   a. Constant-flow hydronic systems.
   b. Variable-flow hydronic systems.
   c. Primary-secondary hydronic systems.

3. Various HVAC Equipment.

   a. Heat Exchangers.
   b. Motors.
   c. Chillers.
   d. Cooling Towers.
   e. Condensing Units.
   f. Boilers.
   g. Heat Transfer Coils.

4. Domestic Heater Systems.

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 entity engaged to perform TAB Work.

1.4 ACTION SUBMITTALS

A. LEED Submittals:

1. Air-Balance Report for Prerequisite IEQ 1: Documentation of work performed for ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
2. TAB Report for Prerequisite EA 2: Documentation of work performed for ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: Within the following number of days of the Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article;
1. 30 days.

B. Certified TAB reports.

C. 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 Contractor Qualifications: Engage a TAB entity certified by **AABC** or **NEBB**.

1. TAB Field Supervisor: Employee of the TAB contractor and certified by **AABC** or **NEBB** and shall be the same as the TAB Contractor.
2. TAB Technician: Employee of the TAB contractor and who is certified by **AABC** or **NEBB** as a TAB technician and shall be the same as the TAB Contractor.

B. Certify TAB field data reports and perform the following:

1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.

C. TAB Report Forms: Use standard TAB contractor's forms approved by:
   1. Architect .

D. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

E. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

F. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

1.7 PROJECT CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.8 COORDINATION

A. Notice: Provide [**seven**] days' advance notice for each test. Include scheduled test dates and times.

B. Perform TAB after leakage and pressure tests on the following distribution systems have been satisfactorily completed:
   1. Air .
   2. Water .
   3. Air and water .

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 TAB SPECIALISTS

A. Subject to compliance with requirements, **engage one of the following**:

   1. BTC Service.
   2. Certified Test & Balance.
   3. Diamond Test & Balance.
   4. RS Analysis.
   5. Test & Balance Inc.

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 systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are 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:
   1. Ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they meet the leakage class of connected ducts as specified in:
      a. Section 233113 "Metal Ducts"
   2. Verify ceiling plenums and underfloor air plenums used for supply, return or relief air are properly separated from adjacent areas.
   3. Verify that penetrations in plenum walls are sealed and fire-stopped if required.

F. Examine equipment performance data including fan and pump curves.

   1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
   2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.

K. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.

L. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

N. Examine system pumps to ensure absence of entrained air in the suction piping.

O. Examine operating safety interlocks and controls on HVAC equipment.

P. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.3 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Complete system-readiness checks and prepare reports. Verify the following:

1. Permanent electrical-power wiring is complete.
2. Hydronic systems are filled, clean, and free of air.
3. Automatic temperature-control systems are operational.
4. Equipment and duct access doors are securely closed.
5. Balance, smoke, and fire dampers are open.
6. Isolating and balancing valves are open and control valves are operational.
7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
8. Windows and doors can be closed so indicated conditions for system operations can be met.

3.4 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in this section and:

1. AABC's "National Standards for Total System Balance"

2. Comply with requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 230713 "Duct Insulation,"

Section 230716 "HVAC Equipment Insulation," and Section 230719 "HVAC Piping Insulation."

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in **inch-pound (IP)** .

3.5 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling-unit components.

L. Verify that air duct system is sealed as specified in Section 233113 "Metal Ducts."

3.6 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.

a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.

2. Measure fan static pressures as follows to determine actual static pressure:

   a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
   b. Measure static pressure directly at the fan outlet or through the flexible connection.
   c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
   d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.

   a. Report the cleanliness status of filters and the time static pressures are measured.

4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
6. Obtain approval from one of the following entities 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:
   a. Architect .
7. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.

1. Measure airflow of submain and branch ducts.

   a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.

2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.

3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

C. Measure air outlets and inlets without making adjustments.

1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.

1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.7 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a minimum set-point airflow with the remainder at maximum-airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.

B. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

1. Set outdoor-air dampers at minimum, and set return- and exhaust-air dampers at a position that simulates full-cooling load.
2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure 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.
3. Measure total system airflow. Adjust to within indicated airflow.
4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.

    a. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.

6. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.

7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.
8. Record final fan-performance data.

C. Pressure-Dependent, Variable-Air-Volume Systems without Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

1. Balance variable-air-volume systems the same as described for constant-volume air systems.
2. Set terminal units and supply fan at full-airflow condition.
3. Adjust inlet dampers of each terminal unit to indicated airflow and verify operation of the static-pressure controller. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
4. Readjust fan airflow for final maximum readings.
5. Measure operating static pressure at the sensor that controls the supply fan if one is installed, and verify operation of the static-pressure controller.
6. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.

    a. If air outlets are out of balance at minimum airflow, report the condition but leave the outlets balanced for maximum airflow.

7. Measure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.

D. Pressure-Dependent, Variable-Air-Volume Systems with Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

1. Set system at maximum indicated airflow by setting the required number of terminal units at minimum airflow. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.
2. Adjust supply fan to maximum indicated airflow with the variable-airflow controller set at maximum airflow.
3. Set terminal units at full-airflow condition.
4. Adjust terminal units starting at the supply-fan end of the system and continuing progressively to the end of the system. Adjust inlet dampers of each terminal unit to indicated airflow. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
5. Adjust terminal units for minimum airflow.
6. Measure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.

3.8 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports with pertinent design data, and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against the approved pump flow rate. Correct variations that exceed plus or minus 5 percent.

B. Prepare schematic diagrams of systems' "as-built" piping layouts.

C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:

1. Open all manual valves for maximum flow.
2. Check liquid level in expansion tank.
3. Check makeup water-station pressure gage for adequate pressure for highest vent.
4. Check flow-control valves for specified sequence of operation, and set at indicated flow.
5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
6. Set system controls so automatic valves are wide open to heat exchangers.
7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.9 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

A. Measure water flow at pumps. Use the following procedures except for positive-displacement pumps:

1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.

   a. If impeller sizes must be adjusted to achieve pump performance, obtain approval from the following entity and comply with requirements in Section 232123 "Hydronic Pumps." :
      1) [Architect] .

2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.

   a. Monitor motor performance during procedures and do not operate motors in overload conditions.

3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake

horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.

4. Report flow rates that are not within plus or minus 10 percent of design.

B. Measure flow at all automatic flow control valves to verify that valves are functioning as designed.

C. Measure flow at all pressure-independent characterized control valves, with valves in fully open position, to verify that valves are functioning as designed.

D. Set calibrated balancing valves, if installed, at calculated presettings.

E. Measure flow at all stations and adjust, where necessary, to obtain first balance.

1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.

F. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.

G. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:

1. Determine the balancing station with the highest percentage over indicated flow.
2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
3. Record settings and mark balancing devices.

H. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.

I. Measure the differential-pressure-control-valve settings existing at the conclusion of balancing.

J. Check settings and operation of each safety valve. Record settings.

3.10 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

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

3.11 PROCEDURES FOR PRIMARY-SECONDARY HYDRONIC SYSTEMS

A. Balance the primary circuit flow first and then balance the secondary circuits.

3.12 PROCEDURES FOR HEAT EXCHANGERS

A. Measure water flow through all circuits.

B. Adjust water flow to within specified tolerances.

C. Measure inlet and outlet water temperatures.

D. Measure inlet steam pressure.

E. Check settings and operation of safety and relief valves. Record settings.

3.13 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. Efficiency rating.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.14 PROCEDURES FOR CHILLERS

A. 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. For water-cooled chillers, 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. For air-cooled chillers, verify condenser-fan rotation and record fan and motor data including number of fans and entering- and leaving-air temperatures.

3.15 PROCEDURES FOR COOLING TOWERS

A. Shut off makeup water for the duration of the test, and verify that makeup and blowdown systems are fully operational after tests and before leaving the equipment. Perform the following tests and record the results:

1. Measure condenser-water flow to each cell of the cooling tower.
2. Measure entering- and leaving-water temperatures.
3. Measure wet- and dry-bulb temperatures of entering air.
4. Measure wet- and dry-bulb temperatures of leaving air.
5. Measure condenser-water flow rate recirculating through the cooling tower.
6. Measure cooling-tower spray pump discharge pressure.
7. Adjust water level and feed rate of makeup water system.
8. Measure flow through bypass.

3.16 PROCEDURES FOR CONDENSING UNITS

A. Verify proper rotation of fans.

B. Measure entering- and leaving-air temperatures.

C. Record compressor data.

3.17 PROCEDURES FOR BOILERS

A. Hydronic Boilers: Measure and record entering- and leaving-water temperatures and water flow.

B. Steam Boilers: Measure and record entering-water temperature and flow and leaving-steam pressure, temperature, and flow.

3.18 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each water coil:

1. Entering- and leaving-water temperature.
2. Water flow rate.
3. Water pressure drop.
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 electric heating coil:

1. Nameplate data.
2. Airflow.
3. Entering- and leaving-air temperature at full load.
4. Voltage and amperage input of each phase at full load and at each incremental stage.
5. Calculated kilowatt at full load.
6. Fuse or circuit-breaker rating for overload protection.

C. Measure, adjust, and record the following data for each steam coil:

1. Dry-bulb temperature of entering and leaving air.
2. Airflow.
3. Air pressure drop.
4. Inlet steam pressure.

D. Measure, adjust, and record the following data for each refrigerant coil:

1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.
4. Air pressure drop.
5. Refrigerant suction pressure and temperature.

3.19 DOMESTIC HEATER SYSTEMS

A. Test domestic heater system per Engineer’s instructions.

3.20 TOLERANCES

A. Set HVAC system's air flow rates and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: **Plus or minus 10 percent .**
2. Air Outlets and Inlets: **Plus or minus 10 percent .**
3. Heating-Water Flow Rate: **Plus or minus 10 percent .**
4. Cooling-Water Flow Rate: **Plus or minus 10 percent .**

3.21 REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to

HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. Status Reports: Prepare progress reports on the following interval 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;
   1. Weekly.

3.22 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.

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 contractor.
   3. Project name.
   4. Project location.
   5. Architect's name and address.
   6. Engineer's name and address.
   7. Contractor's name and address.
   8. Report date.
   9. Signature of TAB supervisor who certifies the report.
   10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
   11. Summary of contents including the following:

      a. Indicated versus final performance.
      b. Notable characteristics of systems.
      c. Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer's name, type, size, and fittings.
14. Notes to explain why certain final data in the body of reports vary from indicated values.
15. Test conditions for fans and pump performance forms including the following:

    a. Settings for outdoor-, return-, and exhaust-air dampers.
    b. Conditions of filters.
    c. Cooling coil, wet- and dry-bulb conditions.
    d. Face and bypass damper settings at coils.
    e. Fan drive settings including settings and percentage of maximum pitch diameter.
    f. Inlet vane settings for variable-air-volume systems.
    g. Settings for supply-air, static-pressure controller.
    h. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

1. Quantities of outdoor, supply, return, and exhaust airflows.
2. Water and steam flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Terminal units.
6. Balancing stations.
7. Position of balancing devices.

E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:

1. Unit Data:

    a. Unit identification.
    b. Location.
    c. Make and type.
    d. Model number and unit size.
    e. Manufacturer's serial number.
    f. Unit arrangement and class.
    g. Discharge arrangement.
    h. Sheave make, size in inches, and bore.
    i. Center-to-center dimensions of sheave, and amount of adjustments in inches.
    j. Number, make, and size of belts.
    k. Number, type, and size of filters.

2. Motor Data:

    a. Motor make, and frame type and size.
    b. Horsepower and rpm.
    c. Volts, phase, and hertz.
    d. Full-load amperage and service factor.
    e. Sheave make, size in inches, and bore.

f. Center-to-center dimensions of sheave, and amount of adjustments in inches.

3. Test Data (Indicated and Actual Values):

a. Total air flow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan rpm.
d. Discharge static pressure in inches wg.
e. Filter static-pressure differential in inches wg.
f. Preheat-coil static-pressure differential in inches wg.
g. Cooling-coil static-pressure differential in inches wg.
h. Heating-coil static-pressure differential in inches wg.
i. Outdoor airflow in cfm.
j. Return airflow in cfm.
k. Outdoor-air damper position.
l. Return-air damper position.
m. Vortex damper position.

F. Apparatus-Coil Test Reports:

1. Coil Data:

a. System identification.
b. Location.
c. Coil type.
d. Number of rows.
e. Fin spacing in fins per inch o.c.
f. Make and model number.
g. Face area in sq. ft..
h. Tube size in NPS.
i. Tube and fin materials.
j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

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

n. Refrigerant suction temperature in deg F.
o. Inlet steam pressure in psig.

G. Gas- and Oil-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:

1. Unit Data:

a. System identification.
b. Location.
c. Make and type.
d. Model number and unit size.
e. Manufacturer's serial number.
f. Fuel type in input data.
g. Output capacity in Btu/h.
h. Ignition type.
i. Burner-control types.
j. Motor horsepower and rpm.
k. Motor volts, phase, and hertz.
l. Motor full-load amperage and service factor.
m. Sheave make, size in inches, and bore.
n. Center-to-center dimensions of sheave, and amount of adjustments in inches.

2. Test Data (Indicated and Actual Values):

a. Total air flow 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. Air flow 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. Air flow rate in cfm.
c. Air velocity in fpm.
d. Entering-air temperature in deg F.
e. Leaving-air temperature in deg F.
f. Voltage at each connection.
g. Amperage for each phase.

I. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:

a. System identification.
b. Location.
c. Make and type.
d. Model number and size.
e. Manufacturer's serial number.
f. Arrangement and class.
g. Sheave make, size in inches, and bore.
h. Center-to-center dimensions of sheave, and amount of adjustments in inches.

2. Motor Data:

a. Motor make, and frame type and size.
b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches, and bore.
f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan rpm.
d. Discharge static pressure in inches wg.

e. Suction static pressure in inches wg.

J. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:

a. System and air-handling-unit number.
b. Location and zone.
c. Traverse air temperature in deg F.
d. Duct static pressure in inches wg.
e. Duct size in inches.
f. Duct area in sq. ft..
g. Indicated air flow rate in cfm.
h. Indicated velocity in fpm.
i. Actual air flow rate in cfm.
j. Actual average velocity in fpm.
k. Barometric pressure in psig.

K. Air-Terminal-Device Reports:

1. Unit Data:

a. System and air-handling unit identification.
b. Location and zone.
c. Apparatus used for test.
d. Area served.
e. Make.
f. Number from system diagram.
g. Type and model number.
h. Size.
i. Effective area in sq. ft..

2. Test Data (Indicated and Actual Values):

a. Air flow rate in cfm.
b. Air velocity in fpm.
c. Preliminary air flow rate as needed in cfm.
d. Preliminary velocity as needed in fpm.
e. Final air flow rate in cfm.
f. Final velocity in fpm.
g. Space temperature in deg F.

L. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

1. Unit Data:

a. System and air-handling-unit identification.

b. Location and zone.
c. Room or riser served.
d. Coil make and size.
e. Flowmeter type.

2. Test Data (Indicated and Actual Values):

a. Air flow rate in cfm.
b. Entering-water temperature in deg F.
c. Leaving-water temperature in deg F.
d. Water pressure drop in feet of head or psig.
e. Entering-air temperature in deg F.
f. Leaving-air temperature in deg F.

M. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:

1. Unit Data:

a. Unit identification.
b. Location.
c. Service.
d. Make and size.
e. Model number and serial number.
f. Water flow rate in gpm.
g. Water pressure differential in feet of head or psig.
h. Required net positive suction head in feet of head or psig.
i. Pump rpm.
j. Impeller diameter in inches.
k. Motor make and frame size.
l. Motor horsepower and rpm.
m. Voltage at each connection.
n. Amperage for each phase.
o. Full-load amperage and service factor.
p. Seal type.

2. Test Data (Indicated and Actual Values):

a. Static head in feet of head or psig.
b. Pump shutoff pressure in feet of head or psig.
c. Actual impeller size in inches.
d. Full-open flow rate in gpm.
e. Full-open pressure in feet of head or psig.
f. Final discharge pressure in feet of head or psig.
g. Final suction pressure in feet of head or psig.
h. Final total pressure in feet of head or psig.
i. Final water flow rate in gpm.
j. Voltage at each connection.

k. Amperage for each phase.

N. Instrument Calibration Reports:

1. Report Data:

a. Instrument type and make.
b. Serial number.
c. Application.
d. Dates of use.
e. Dates of calibration.

3.23 INSPECTIONS

A. Initial Inspection:

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
2. Check the following for each system:

a. Measure airflow of at least **10** percent of air outlets.
b. Measure water flow of at least **5** percent of terminals.
c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
d. Verify that balancing devices are marked with final balance position.
e. Note deviations from the Contract Documents in the final report.

B. Final Inspection:

1. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by:
a. Architect .
2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of:
a. Architect .
3. The following entity shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day:
a. Architect .
4. 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."

5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:

1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
2. If the second final inspection also fails, Owner may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.

D. Prepare test and inspection reports.

3.24 ADDITIONAL TESTS

A. Within **90 days** of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION 230593

SECTION 230713 - DUCT INSULATION.

PART 1 - GENERAL

1.1 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 duct services:

1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.

B. Related Sections:

1. Section 230716 "HVAC Equipment Insulation."
2. Section 230719 "HVAC Piping Insulation."
3. Section 233113 "Metal Ducts" for duct liners.

1.3 ACTION SUBMITTALS

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

B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content.
2. Laboratory Test Reports for Credit IEQ 4: For adhesives and sealants, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

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

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.
3. Detail application of field-applied jackets.
4. Detail application at linkages of control devices.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

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

C. Field quality-control reports.

1.5 QUALITY ASSURANCE

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

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

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

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

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

C. Coordinate installation and testing of heat tracing.

1.8 SCHEDULING

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

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

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

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

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

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

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

F. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type II for sheet materials.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Aeroflex USA, Inc.; Aerocel.
b. Armacell LLC; AP Armaflex.
c. K-Flex USA; Insul-Sheet, K-Flex Gray Duct Liner, and K-FLEX LS.

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 III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:

a. CertainTeed Corp.; SoftTouch Duct Wrap.
b. Johns Manville; Microlite.
c. Knauf Insulation; Friendly Feel Duct Wrap.

d. Manson Insulation Inc.; Alley Wrap.
e. Owens Corning; SOFTR 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. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:

a. CertainTeed Corp.; Commercial Board.
b. 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.

2.2 FIRE-RATED INSULATION SYSTEMS

A. Fire-Rated Board: Structural-grade, press-molded, xonolite calcium silicate, fireproofing board suitable for operating temperatures up to 1700 deg F. Comply with ASTM C 656, Type II, Grade 6. Tested and certified to provide a [1] 2-hour fire rating by an NRTL acceptable to authorities having jurisdiction.

1. Products: Subject to compliance with requirements, provide the following:

a. Johns Manville; Super Firetemp M.

B. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a [1] 2 -hour fire rating by an NRTL acceptable to authorities having jurisdiction.

1. Products: Subject to compliance with requirements, provide one of the following :

a. CertainTeed Corp.; FlameChek.
b. Johns Manville; Firetemp Wrap.
c. Nelson Fire Stop Products; Nelson FSB Flameshield Blanket.
d. Thermal Ceramics; FireMaster Duct Wrap.
e. 3M; Fire Barrier Wrap Products.
f. Unifrax Corporation; FyreWrap.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Aeroflex USA, Inc.; Aeroseal.
   b. Armacell LLC; Armaflex 520 Adhesive.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
   d. K-Flex USA; R-373 Contact Adhesive.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

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

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
   b. Eagle Bridges - Marathon Industries; 225.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
   d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

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

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
   b. Eagle Bridges - Marathon Industries; 225.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.
   d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
b. Vimasco Corporation; 749.

2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
5. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-10.
b. Eagle Bridges - Marathon Industries; 550.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 46-50.
d. Mon-Eco Industries, Inc.; 55-50.
e. Vimasco Corporation; WC-1/WC-5.

2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: 60 percent by volume and 66 percent by weight.
5. Color: White.

2.5 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 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2. Products: Subject to compliance with requirements, provide one of the following:

   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-50 AHV2.
   b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-36.
   c. Vimasco Corporation; 713 and 714.

3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct insulation.
4. Service Temperature Range: 0 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, provide one of the following:

   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
   b. Eagle Bridges - Marathon Industries; 405.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
   d. Mon-Eco Industries, Inc.; 44-05.

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, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.7 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. 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. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. Metal Jacket:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Metal Jacketing Systems.
b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
c. RPR Products, Inc.; Insul-Mate.

2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.

a. Sheet and roll stock ready for shop or field sizing.
b. Finish and thickness are indicated in field-applied jacket schedules.
c. Moisture Barrier for Indoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.

2.9 TAPES

A. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one of the following:

a. ABI, Ideal Tape Division; 491 AWF FSK.
b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
c. Compac Corporation; 110 and 111.
d. Venture Tape; 1525 CW NT, 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.

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

1. Products: Subject to compliance with requirements, provide one of the following:

a. ABI, Ideal Tape Division; 488 AWF.
b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
c. Compac Corporation; 120.
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, provide one of the following:

a. ITW Insulation Systems; Gerrard Strapping and Seals.
b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.

2. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing seal.
3. 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, 0.135-inch- diameter shank, length to suit depth of insulation indicated.

a. Products: Subject to compliance with requirements, provide one of 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, 0.135-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, provide one of the following:

      1) AGM Industries, Inc.; CHP-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, provide one of the following:

      1) AGM Industries, Inc.; Tactoo Perforated Base Insul-Hangers.
      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. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

   a. Products: Subject to compliance with requirements, provide one of the following:

      1) GEMCO; Nylon Hangers.
      2) Midwest Fasteners, Inc.; Nylon Insulation Hangers.

   b. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
   c. Spindle: Nylon, 0.106-inch- diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
   d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

5. 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, provide one of the following:

      1) AGM Industries, Inc.; Tactoo Self-Adhering Insul-Hangers.
      2) GEMCO; Peel & Press.
      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.

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

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

3.2 PREPARATION

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

3.3 GENERAL INSTALLATION REQUIREMENTS

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

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

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during application and finishing.

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

H. Install insulation with least number of joints practical.

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

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

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

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

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

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

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

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.4 PENETRATIONS

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

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

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

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

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

D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.

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

E. Insulation Installation at Floor Penetrations:

1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

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

3.6 INSTALLATION OF MINERAL-FIBER INSULATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

    a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not overcompress insulation during installation.
    e. Impale insulation over pins and attach speed washers.
    f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

    a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
    b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.

5. Overlap 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.

B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

    a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not overcompress insulation during installation.
    e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

    a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.

5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.7 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch- thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.8 FIRE-RATED INSULATION SYSTEM INSTALLATION

A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.

B. Insulate duct access panels and doors to achieve same fire rating as duct.

C. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Section 078413 "Penetration Firestopping."

3.9 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

    a. Finish Coat Material: Interior, flat, latex-emulsion size.

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

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.10 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. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location (s) for each duct system defined in the "Duct Insulation Schedule, General" Article.

D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

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.

B. Items Not Insulated:

1. Fibrous-glass ducts.
2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
3. Factory-insulated flexible ducts.
4. Factory-insulated plenums and casings.
5. Flexible connectors.
6. Vibration-control devices.
7. Factory-insulated access panels and doors.

3.12 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Concealed, round and flat-oval, supply-air duct insulation shall be one of the following:

1. Flexible Elastomeric: 1 inch thick.
2. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.

B. Concealed, round and flat-oval, return-air duct insulation shall be one of the following:

1. Flexible Elastomeric: 1 inch thick.
2. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.

C. Concealed, round and flat-oval, outdoor-air duct insulation shall be one of the following:

1. Flexible Elastomeric: 1 inch thick.
2. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.

D. Concealed, rectangular, supply-air duct insulation shall be one of the following:

1. Flexible Elastomeric: 1 inch thick.
2. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.

E. Concealed, rectangular, return-air duct insulation shall be one of the following:

1. Flexible Elastomeric: 1 inch thick.
2. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.

F. Concealed, rectangular, outdoor-air duct insulation shall be one of the following:

1. Flexible Elastomeric: 1 inch thick.
2. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.

G. Concealed, outdoor-air plenum insulation shall be one of the following:

1. Flexible Elastomeric: 1 inch thick.
2. Mineral-Fiber Blanket: 2 inches 1.5-lb/cu. ft. nominal density.

END OF SECTION 230713

SECTION 230716 - HVAC EQUIPMENT 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 HVAC equipment that is not factory insulated:
   1. Heat exchangers.
   2. Chilled-water pumps.
   3. Condenser-water pumps.
   4. Heating, hot-water pumps.
   5. Expansion/compression tanks.
   6. Air separators.
   7. Thermal storage tanks.

B. Related Sections:

   1. Section 230713 "Duct Insulation."
   2. Section 230719 "HVAC Piping Insulation."

1.3 ACTION SUBMITTALS

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

B. LEED Submittals:

   1. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content.
   2. Laboratory Test Reports for Credit IEQ 4: For adhesives and sealants, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

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

   1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
   2. Detail attachment and covering of heat tracing inside insulation.

3. Detail removable insulation at equipment connections.
4. Detail application of field-applied jackets.
5. Detail application at linkages of control devices.
6. Detail field application for each equipment type.

1.4 INFORMATIONAL SUBMITTALS

A. 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.

B. Field quality-control reports.

1.5 QUALITY ASSURANCE

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

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

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

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 COORDINATION

A. Coordinate clearance requirements with equipment Installer for equipment insulation application.

1.8 SCHEDULING

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

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

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Breeching Insulation Schedule" and "Equipment Insulation Schedule" articles for where insulating materials shall be applied.

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

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

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

F. Calcium Silicate:

1. Products: Subject to compliance with requirements:
   a. Provide the following :
      1) Industrial Insulation Group (IIG); Thermo-12 Gold.

2. Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.

G. Mineral-Fiber Blanket Insulation:

1. Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290;
   a. Type II with factory-applied vinyl jacket.

2. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

3. Products: Subject to compliance with requirements, provide one of the following:

a. CertainTeed Corp.; SoftTouch Duct Wrap.
b. Johns Manville; Microlite.
c. Knauf Insulation; Friendly Feel Duct Wrap.
d. Manson Insulation Inc.; Alley Wrap.
e. Owens Corning; SOFTR All-Service Duct Wrap.

H. Mineral-Fiber Board Insulation:

1. Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. Provide insulation:
   a. With factory-applied ASJ or with factory-applied FSK jacket.

2. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

3. Products: Subject to compliance with requirements, provide one of the following:

   a. CertainTeed Corp.; CertaPro 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, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ or FSK jacket complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. CertainTeed Corp.; CrimpWrap.
   b. Johns Manville; MicroFlex.
   c. Knauf Insulation; Pipe and Tank Insulation.
   d. Manson Insulation Inc.; AK Flex.
   e. Owens Corning; Fiberglas Pipe and Tank Insulation.

2.2 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

1. Products: Subject to compliance with requirements:
   a. Provide the following :
      1) Ramco Insulation, Inc.; Super-Stik.

B. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.

1. Products: Subject to compliance with requirements:
   a. Provide the following
      1) Ramco Insulation, Inc.; Ramcote 1200 and Quik-Cote.

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. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F.

1. Products: Subject to compliance with requirements, Subject to compliance with requirements, provide one of the following:

   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-97.
   b. Eagle Bridges - Marathon Industries; 290.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 81-27.
   d. Mon-Eco Industries, Inc.; 22-30.
   e. Vimasco Corporation; 760.

2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

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

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
   b. Eagle Bridges - Marathon Industries; 225.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
   d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

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

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
b. Eagle Bridges - Marathon Industries; 225.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.
d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

E. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Dow Corning Corporation; 739, Dow Silicone.
b. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
c. P.I.C. Plastics, Inc.; Welding Adhesive.
d. Speedline Corporation; Polyco VP Adhesive.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Foster Brand, Specialty Construction Brands, Inc., a business of H .B. Fuller Company; 30-80/30-90.
b. 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, 58 percent by volume and 70 percent by weight.
5. Color: White.

C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-30.
b. Eagle Bridges - Marathon Industries; 501.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-35.
d. Mon-Eco Industries, Inc.; 55-10.

2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
3. Service Temperature Range: 0 to 180 deg F.
4. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
5. Color: White.

D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Encacel.
b. Eagle Bridges - Marathon Industries; 570.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 60-95/60-96.

2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
3. Service Temperature Range: Minus 50 to plus 220 deg F.
4. Solids Content: ASTM D 1644, 33 percent by volume and 46 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. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-50 AHV2.
b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-36.
c. Vimasco Corporation; 713 and 714.

2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over equipment insulation.
3. Service Temperature Range: 0 to plus 180 deg F.
4. Color: White.

2.6 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
b. Eagle Bridges - Marathon Industries; 405.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
d. Mon-Eco Industries, Inc.; 44-05.

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, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements:
a. Provide the following :
1) Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 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, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.7 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.
4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
5. PVDC Jacket for Indoor Applications: 4-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perm when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
   a. Products: Subject to compliance with requirements:
      1) Provide the following :
         a) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.

6. PVDC Jacket for Outdoor Applications: 6-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perm when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
   a. Products: Subject to compliance with requirements:
      1) Provide the following :
         a) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.

7. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.
   a. Products: Subject to compliance with requirements:
      1) Provide the following :
         a) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.

8. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E 96, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.8 FIELD-APPLIED CLOTHS

A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd..

1. Products: Subject to compliance with requirements:
   a. Provide the following :
      1) Alpha Associates, Inc.; Alpha-Maritex 84215 and 84217/9485RW, Luben 59.

2.9 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Johns Manville; Zeston.
   b. P.I.C. Plastics, Inc.; FG Series.
   c. Proto Corporation; LoSmoke.
   d. Speedline Corporation; SmokeSafe.

2. Adhesive: As recommended by jacket material manufacturer.
3. Color: White:
4. Factory-fabricated tank heads and tank side panels.

D. Metal Jacket:

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Metal Jacketing Systems.
   b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
   c. RPR Products, Inc.; Insul-Mate.

2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.

   a. Sheet and roll stock ready for shop or field sizing.

b. Finish and thickness are indicated in field-applied jacket schedules.

c. Moisture Barrier for Indoor Applications:
   1) 1-mil- thick, heat-bonded polyethylene and kraft paper.

d. Moisture Barrier for Outdoor Applications:
   1) 3-mil- thick, heat-bonded polyethylene and kraft paper.

e. Factory-Fabricated Fitting Covers:

   1) Same material, finish, and thickness as jacket.
   2) Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
   3) Tee covers.
   4) Flange and union covers.
   5) End caps.
   6) Beveled collars.
   7) Valve covers.
   8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

E. Self-Adhesive Outdoor Jacket: 60-mil- thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a crosslaminated polyethylene film covered with:

1. Facing:
   a. White aluminum-foil.

2. Products: Subject to compliance with requirements:
   a. Provide the following :
      1) Polyguard Products, Inc.; Alumaguard 60.

F. PVDC Jacket for Indoor Applications: 4-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perm when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.

1. Products: Subject to compliance with requirements:
   a. Provide the following :
      1) Dow Chemical Company (The), Saran 540 Vapor Retarder Film.

G. PVDC Jacket for Outdoor Applications: 6-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perm when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.

1. Products: Subject to compliance with requirements:
   a. Provide the following :
      1) Dow Chemical Company (The), Saran 560 Vapor Retarder Film.

H. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.

1. Products: Subject to compliance with requirements:
   a. Provide the following :
      1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.

2.10 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. ABI, Ideal Tape Division; 428 AWF ASJ.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
   c. Compac Corporation; 104 and 105.
   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, provide one of the following:

   a. ABI, Ideal Tape Division; 491 AWF FSK.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
   c. Compac Corporation; 110 and 111.
   d. Venture Tape; 1525 CW NT, 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. Subject to compliance with requirements, provide one of the following:

   a. ABI, Ideal Tape Division; 370 White PVC tape.

b. Compac Corporation; 130.
c. Venture Tape; 1506 CW NS.

2. Width: 2 inches.
3. Thickness: 6 mils.
4. Adhesion: 64 ounces force/inch in width.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch in width.

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

1. Products: Subject to compliance with requirements, provide one of the following:

a. ABI, Ideal Tape Division; 488 AWF.
b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
c. Compac Corporation; 120.
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.

E. PVDC Tape for Indoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.

1. Products: Subject to compliance with requirements:
a. Provide the following :
1) Dow Chemical Company (The); Saran 540 Vapor Retarder Tape.

2. Width: 3 inches.
3. Film Thickness: 4 mils.
4. Adhesive Thickness: 1.5 mils.
5. Elongation at Break: 145 percent.
6. Tensile Strength: 55 lbf/inch in width.

F. PVDC Tape for Outdoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.

1. Products: Subject to compliance with requirements:
a. Provide the following :
1) Dow Chemical Company (The); Saran 560 Vapor Retarder Tape.

2. Width: 3 inches.
3. Film Thickness: 6 mils.
4. Adhesive Thickness: 1.5 mils.
5. Elongation at Break: 145 percent.
6. Tensile Strength: 55 lbf/inch in width.

2.11 SECUREMENTS

A. Bands:

1. Products: Subject to compliance with requirements, provide one of the following:

   a. ITW Insulation Systems; Gerrard Strapping and Seals.
   b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.

2. Stainless Steel:
   a. ASTM A 167 or ASTM A 240,
   b. Type:
      1) Grade 316.
   c. 0.015 inch thick
   d. Width:
      1) 3/4 inch .
   e. Seal:
      1) Wing seal.
3. Aluminum: ASTM B 209, Temper H-14;
   a. Alloy; 3003, 3005, 3105, or 5005;
   b. 0.020 inch thick.
   c. Width;
      1) 3/4 inch.
   d. Seal;
      1) Wing 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:
   a. Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, length to suit depth of insulation indicated. Shank diameter;
      1) 0.135-inch-.

   b. Products: Subject to compliance with requirements, provide one of 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:
   a. Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer. Shank diameter;
      1) 0.135-inch-.

b. Products: Subject to compliance with requirements, provide one of the following:

1) AGM Industries, Inc.; CHP-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.

a. Products: Subject to compliance with requirements, provide one of the following:

1) AGM Industries, Inc.; Tactoo Perforated Base Insul-Hangers.
2) GEMCO; Perforated Base.
3) Midwest Fasteners, Inc.; Spindle.

b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
c. Spindle: Fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated. Material:
1) Copper- or zinc-coated, low-carbon steel.
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. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.

a. Products: Subject to compliance with requirements, provide one of the following:

1) GEMCO; Nylon Hangers.
2) Midwest Fasteners, Inc.; Nylon Insulation Hangers.

b. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
c. Spindle: Nylon, 0.106-inch- diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

5. 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.

a. Products: Subject to compliance with requirements, provide one of the following:

1) AGM Industries, Inc.; Tactoo Self-Adhering Insul-Hangers, Series.
2) GEMCO; Peel & Press.
3) Midwest Fasteners, Inc.; Self Stick.

b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.

c. Spindle: Fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated. Material;
1) Copper- or zinc-coated, low-carbon steel.

d. Adhesive-backed base with a peel-off protective cover.

6. Insulation-Retaining Washers:
a. Self-locking washers formed from 0.016-inch- thick sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter. Material:
1) Galvanized-steel sheet.

b. Products: Subject to compliance with requirements, provide one of the following:

1) AGM Industries, Inc.; RC-150.
2) GEMCO; R-150.
3) Midwest Fasteners, Inc.; WA-150.
4) Nelson Stud Welding; Speed Clips.

c. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

7. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

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

1) GEMCO.
2) Midwest Fasteners, Inc.

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

D. Wire:
1. Material;
a. 0.080-inch nickel-copper alloy.

1. Manufacturers: Subject to compliance with requirements:
a. Provide the following :
1) C & F Wire.

2.12 CORNER ANGLES

A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.

C. Stainless-Steel Corner Angles: 0.024 inch thick, minimum 1 by 1 inch, stainless steel according to ASTM A 167 or ASTM A 240, Material Type:
   1. Grade 316 .

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

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

3.2 PREPARATION

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

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

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

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

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

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment.

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

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during application and finishing.

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

H. Install insulation with least number of joints practical.

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

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

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

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

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

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

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

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

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

3.4 INSTALLATION OF EQUIPMENT, TANK, AND VESSEL INSULATION

A. Mineral-Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for the following coverage of tank and vessel surfaces;
   a. 100 percent .
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. 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:
   a. Mateiral;
      1) Galvanized steel
   b. Thickness; (minimum);
      1) 0.060 inch .

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.

3.5 INSTALLATION OF CALCIUM SILICATE INSULATION

3.6 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. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

3.7 EQUIPMENT INSULATION SCHEDULE

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

B. Insulate indoor and outdoor equipment that is not factory insulated.

C. Heat-exchanger (water-to-water for heating service) insulation shall be one of the following:

1. Calcium Silicate: 3 inches thick.
2. Mineral-Fiber Board:
   a. Thickness; 2 inches .
   b. Nominal Density:
      1) 3-lb/cu. ft.
3. Mineral-Fiber Pipe and Tank: 2 inches thick.

D. Chilled-water pump insulation shall be one of the following:

1. Mineral-Fiber Board:
   a. Thickness; 2 inches .

b. Nominal Density:
1) 3-lb/cu. ft.

2. Mineral-Fiber Blanket Insulation: 2 inches thick.

E. Chilled-water expansion/compression tank insulation shall be one of the following:

1. Mineral-Fiber Board:
a. Thickness; 1 inches .
b. Nominal Density:
1) 3-lb/cu. ft.

2. Mineral-Fiber Pipe and Tank: 1 inch thick.
3. Calcium Silicate: 1-1/2 inches thick.

F. Heating-hot-water expansion/compression tank insulation shall be one of the following:

1. Calcium Silicate: 2 inches thick.

2. Mineral-Fiber Board:
a. Thickness; 1 inches .
b. Nominal Density:
1) 3-lb/cu. ft.

3. Mineral-Fiber Pipe and Tank: 1 inch thick.

G. Chilled-water air-separator insulation shall be one of the following:

1. Mineral-Fiber Board:
a. Thickness; 1 inches .
b. Nominal Density:
1) 3-lb/cu. ft.

2. Mineral-Fiber Pipe and Tank: 1 inch thick.
3. Calcium Silicate: 2 inches thick.

H. Heating-hot-water air-separator insulation shall be one of the following:

1. Calcium Silicate: 3 inches thick.

2. Mineral-Fiber Board:
a. Thickness; 2 inches .
b. Nominal Density:
1) 3-lb/cu. ft.

3. Mineral-Fiber Pipe and Tank: 2 inches thick.

3.8 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. Equipment, Concealed:

1. PVC:
   a. Color;
      1) Plain.
   b. Thickness;
      1) 20 mils.

2. Aluminum:
   a. Texture;
      1) Smooth.
   b. Thickness;
      1) 0.032 inch.

D. Equipment, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:

1. PVC:
   a. Color;
      1) Plain.
   b. Thickness;
      1) 20 mils.

2. Aluminum:
   a. Texture;
      1) Stucco Embossed.
   b. Thickness;
      1) 0.032 inch.

E. Equipment, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger Than 72 Inches:

1. Aluminum:
   a. Finish;
      1) Bare.
   b. Texture;
      1) Stucco Embossed.
   c. Pattern;
      1) 2-1/2-Inch- Deep Corrugations.
   d. Thickness:
      1) 0.040 inch.

END OF SECTION 230716

SECTION 230719 - HVAC 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 HVAC piping systems:

1. Condensate drain piping.
2. Chilled-water and brine piping.
3. Condenser-water piping.
4. Heating hot-water piping.
5. Refrigerant suction and hot-gas piping.

1.3 DEFINITIONS:

A. Refer to Section 230500 “Common Work Results for HVAC”.

1.4 ACTION SUBMITTALS

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

B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content.
2. Laboratory Test Reports for Credit IEQ 4: For adhesives and sealants, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

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

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail attachment and covering of heat tracing inside insulation.
3. Detail insulation application at pipe expansion joints for each type of insulation.

4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
5. Detail removable insulation at piping specialties.
6. Detail application of field-applied jackets.
7. Detail application at linkages of control devices.

1.5 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.

1.6 QUALITY ASSURANCE

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

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

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

1.7 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.

1.8 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for

installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.9 SCHEDULING

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

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

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

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

B. Insulation for below-ambient service requires a vapor-barrier.

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

D. 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.

E. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

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

G. Calcium Silicate:

1. Products: Subject to compliance with requirements, provide the following:

   a. Industrial Insulation Group (IIG); Thermo-12 Gold.

2. Preformed Pipe Sections: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
3. Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.

4. Prefabricated Fitting Covers: Comply with ASTM C 450 and ASTM C 585 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.

H. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Aeroflex USA, Inc.; Aerocel.
b. Armacell LLC; AP Armaflex.
c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.

I. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:

a. CertainTeed Corp.; SoftTouch Duct Wrap.
b. Johns Manville; Microlite.
c. Knauf Insulation; Friendly Feel Duct Wrap.
d. Manson Insulation Inc.; Alley Wrap.
e. Owens Corning; SOFTR All-Service Duct Wrap.

J. Mineral-Fiber, Preformed Pipe Insulation:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Fibrex Insulations Inc.; Coreplus 1200.
b. Johns Manville; Micro-Lok.
c. Knauf Insulation; 1000-Degree 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.
3. Type II, 1200 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type II, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

K. 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 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. CertainTeed Corp.; CrimpWrap.
   b. Johns Manville; MicroFlex.
   c. Knauf Insulation; Pipe and Tank Insulation.
   d. Manson Insulation Inc.; AK Flex.
   e. Owens Corning; Fiberglas Pipe and Tank Insulation.

L. Prefabricated Thermal Insulating Fitting Covers: Comply with ASTM C 450 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.

2.2 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

1. Products: Subject to compliance with requirements, provide the following:

   a. Ramco Insulation, Inc.; Super-Stik.

B. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.

1. Products: Subject to compliance with requirements, provide the following:

   a. Ramco Insulation, Inc.; Ramcote 1200 and Quik-Cote.

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. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-97.
   b. Eagle Bridges - Marathon Industries; 290.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 81-27.
   d. Mon-Eco Industries, Inc.; 22-30.
   e. Vimasco Corporation; 760.

2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Aeroflex USA, Inc.; Aeroseal.
   b. Armacell LLC; Armaflex 520 Adhesive.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
   d. K-Flex USA; R-373 Contact Adhesive.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

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

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
   b. Eagle Bridges - Marathon Industries; 225.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
   d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

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

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
   b. Eagle Bridges - Marathon Industries; 225.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.
   d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

F. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Dow Corning Corporation; 739, Dow Silicone.
   b. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
   c. P.I.C. Plastics, Inc.; Welding Adhesive.
   d. Speedline Corporation; Polyco VP Adhesive.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
b. Vimasco Corporation; 749.

2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
5. Color: White.

C. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below-ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Encacel.
b. Eagle Bridges - Marathon Industries; 570.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 60-95/60-96.

2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
3. Service Temperature Range: Minus 50 to plus 220 deg F.
4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
5. Color: White.

D. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-10.
b. Eagle Bridges - Marathon Industries; 550.

c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 46-50.
d. Mon-Eco Industries, Inc.; 55-50.
e. Vimasco Corporation; WC-1/WC-5.

2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: 60 percent by volume and 66 percent by weight.
5. Color: White.

2.5 SEALANTS

A. ASJ Flashing Sealants and PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 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, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.6 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

2.7 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, provide one of the following:

a. Johns Manville; Zeston.
b. P.I.C. Plastics, Inc.; FG Series.

c. Proto Corporation; LoSmoke.
d. Speedline Corporation; SmokeSafe.

2. Adhesive: As recommended by jacket material manufacturer.
3. Color: Color-code jackets based on system.
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.

C. Metal Jacket:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Metal Jacketing Systems.
b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
c. RPR Products, Inc.; Insul-Mate.

2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.

a. Sheet and roll stock ready for shop or field sizing or factory cut and rolled to size.
b. Finish and thickness are indicated in field-applied jacket schedules.
c. Moisture Barrier for Indoor Applications: 1-mil- thick, heat-bonded polyethylene and kraft paper. [3-mil- thick, heat-bonded polyethylene and kraft paper] [2.5-mil-thick polysurlyn].
d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper. [2.5-mil- thick polysurlyn].
e. 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.

2.8 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. ABI, Ideal Tape Division; 428 AWF ASJ.
    b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
    c. Compac Corporation; 104 and 105.
    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. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. ABI, Ideal Tape Division; 370 White PVC tape.
    b. Compac Corporation; 130.
    c. Venture Tape; 1506 CW NS.

2. Width: 2 inches.
3. Thickness: 6 mils.
4. Adhesion: 64 ounces force/inch in width.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch in width.

2.9 SECUREMENTS

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

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

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

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

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

3.3 GENERAL INSTALLATION REQUIREMENTS

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

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

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

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

I. Install insulation with least number of joints practical.

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

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

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

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

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

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

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

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

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

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

4. Manholes.
5. Handholes.
6. Cleanouts.

3.4 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.

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

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape

insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

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

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

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

B. Insulation Installation on Pipe Flanges:

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

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

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

B. Insulation Installation on Pipe Flanges:

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

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.

2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.8 FIELD-APPLIED JACKET INSTALLATION

A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

B. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.9 FINISHES

A. Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

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

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.10 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

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

3.11 INDOOR PIPING INSULATION SCHEDULE

A. Condensate and Equipment Drain Water below 60 Deg F:

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

B. Chilled Water and Brine, above 40 Deg F:

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

2. Insulation runouts not exceeding 48 inches in length for connection to equipment shall be one of the following:

   a. Flexible Elastomeric: 1 inch thick.
   b. Mineral-Fiber, Preformed Pipe, Type I: 1 inch thick

3. Condenser-water supply and return piping located indoors and operating in range of 55 to 105 deg F (13 to 41 deg C) is not always insulated. If condenser-water system operates as part of a water-side economizer cycle or if Project requires condensation control, piping should be insulated.

C. Condenser-Water Supply and Return:

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

D. Heating-Hot-Water Supply and Return, 200 Deg F and Below:

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

2. Greater than NPS 1-1/2 inch : Insulation shall be the following:
   a. Mineral-Fiber, Preformed Pipe, Type I or Pipe and Tank Insulation: 2 inches thick.

3. Insulation for runouts not exceeding 48 inches in length for connection to equipment shall be the following:

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

E. Refrigerant Suction and Hot-Gas Piping:

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

F. Refrigerant Suction and Hot-Gas Flexible Tubing:

1. All Pipe Sizes: Insulation shall be [one of] the following:

   a. Flexible Elastomeric: 1 inch <Insert dimension> thick.

3.12 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Refrigerant Suction and Hot-Gas Piping:

1. All Pipe Sizes: Insulation shall be [one of] the following:
   a. Flexible Elastomeric: 2 inches <Insert dimension> thick.

B. Refrigerant Suction and Hot-Gas Flexible Tubing:

1. All Pipe Sizes: Insulation shall be [one of] the following:

   a. Flexible Elastomeric: 2 inches <Insert dimension> thick.

3.13 OUTDOOR, UNDERGROUND PIPING INSULATION SCHEDULE

A. Loose-fill insulation, for belowground piping, is specified in Section 232113.13 "Underground Hydronic Piping" and Section 336313 "Underground Steam and Condensate Distribution Piping."

B. Chilled Water, All Sizes: Cellular glass, 2 inches thick.

3.14 INDOOR, FIELD-APPLIED JACKET SCHEDULE

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

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

C. Piping, Concealed:

1. None.

D. Piping, Exposed:
   1. PVC, Color-Coded by System: 30 mils thick.

3.15 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

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

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

C. Piping, Concealed:

   1. None.

D. Piping, Exposed:
   1. Aluminum, Stucco Embossed: 0.016 inch thick.

3.16 UNDERGROUND, FIELD-INSTALLED INSULATION JACKET

A. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

END OF SECTION 230719

SECTION 230900 – AUTOMATIC TEMPERATURE CONTROLS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. .This Section includes the Building Management System (BMS) control equipment for HVAC systems and components, including open protocol control components for heating, cooling and ventilations units. The BMS system shall be TAC I/A Schneider Electric StruxureWare by Utah Yamas Controls. The BMS system will seamlessly interface to the existing SUU StruxureWare system

B. Related Sections include the following found in Division 23000 and 26000 Sections of the Specifications:

1. Fire Alarm Systems.
2. Basic Mechanical Requirements.
3. Refrigeration Equipment.
4. Air Handling Equipment.
5. Test and Balance.
6. Basic Electrical Requirements.
7. Cables, Low Voltage. (600 Volts and below)
8. Wiring Devices.
9. Motor Control Centers.
10. Basic Electrical Materials.

1.3 SYSTEM DESCRIPTION ETHERNET (IEEE 802.3), PEER-TO-PEER CSMA/CD

A. Furnish all labor, materials, equipment, and service necessary for a complete and operating temperature control system, utilizing a high speed peer to peer network of interoperable Direct Digital Controls (DDC), Graphical User Interface (GUI) with color graphic displays available for a minimum of at least 64 possible client computers, and electronic interfaces and actuation devices, as shown on the drawings and as described herein.

B. The Local Area Network (LAN) shall be either a 10 or 100 Mpbs Ethernet network supporting LON, BACnet, Java, XML, HTTP, and CORBA IIOP for maximum flexibility for integration of building data with enterprise information systems and providing support for multiple Automation Servers, user workstations and a local host computer system.

C. The Enterprise Ethernet (IEEE 802.3) LAN shall utilize Carrier Sense Multiple/Access/Collision Detect (CSMA/CD), Address Resolution Protocol (ARP) and User Da-

tagram Protocol (UDP) operating at 10 or 100 Mbps.

D. The system will consist of an open architecture that utilizes EIA standard 709.1, the LonTalk™ protocol, as the common communication protocol between all controllers and integral ANSI / ASHRAE™ Standard 135-2004, BACnet functionality to assure interoperability between all system components. Both the LonTalk™ protocol and the ANSI / ASHRAE™ Standard 135-2004, BACnet protocol are required to assure that the project is fully supported by the leading HVAC open protocol to reduce future building maintenance, upgrade, and expansion costs.

E. Where utilized by a LonMark/LonWorks based Control System, LonTalk™ packets may be encapsulated into TCP/IP messages to take advantage of existing infrastructure or to increase network bandwidth.

   1. Any such encapsulation of the LonTalk™ protocol into IP datagrams shall conform to existing LonMark™ guide-lines for such encapsulation and shall be based on industry standard protocols.
   2. The products used in constructing the BMS shall be LonMark™ compliant.
   3. In those instances in which Lon-Mark™ devices are not available, the BMS contractor shall provide LonWorks™ devices with application source code, device resource files, and external interface definitions.

F. The software tools required to network manage both LonTalk™ protocol and the ANSI / ASHRAE™ Standard 135-2004, BACnet protocol must be provided with the system. Drawings are diagrammatic only. Equipment and labor not specifically referred to herein or on the plans that are required to meet the functional intent, shall be provided without additional cost to the Owner. Minimum BACnet compliance is Level 3; with the ability to support data read and write functionality. Physical connection of BACnet devices shall be via Ethernet/Ethernet IP or MS/TP.

G. Complete temperature control system to be DDC with electronic sensors and electronic/electric actuation of Mechanical Equipment Room (MER) valves and dampers and electronic actuation of terminal equipment valves and actuators as specified herein. The BMS is intended to seamlessly connect devices throughout the building regardless of subsystem type, i.e. variable frequency drives, low voltage lighting systems, electrical circuit breakers, power metering and card access should easily coexist on the same network channel.

   1. The supplied system must incorporate the ability to access all data using Java enabled browsers without requiring proprietary operator interface and configuration programs.
   2. An Open DataBase Connectivity (ODBC) or Structured Query Language (SQL) compliant server database is required for all system database parameter storage.

      a. This data shall reside on a supplier-installed server for all database access.
      b. Systems requiring proprietary database and user interface programs shall not be acceptable.
      c. A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer’s internal Intranet network.

d. Systems employing a “flat” single tiered architecture shall not be acceptable.

H. All work described in this section shall be installed, wired, circuit tested and calibrated by factory certified technicians qualified for this work and in the regular employment of the authorized office representing the controls manufacturer. The authorized office shall have a minimum of 10 years of installation experience with the manufacturer and shall provide documentation in the bid and submittal package verifying longevity of the installing company's relationship with the manufacturer when requested. Supervision, calibration and checkout of the system shall be by the employees of the authorized office and shall not be subcontracted. The control contractor shall have an in place support facility within 50 miles of the site with factory certified technicians and engineers, spare parts inventory and all necessary test and diagnostic equipment for the installed system, and the control contractor shall have emergency service available.

1.4 INSTALLATION OF PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION.

A. Sections from Division 23000 :

1. Control Valves.
2. Flow Switches.
3. Temperature Sensor Wells and Sockets.
4. BTU Meters.

B. Sections from Division 23000 :

1. Automatic Dampers.
2. Terminal Unit Controls.
3. Air Flow Monitoring Stations.
4. BTU Meters

1.5 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION.

A. Sections from Division 23000 –

1.6 PRODUCTS NOT FURNISHED OR INSTALLED BUT INTEGRATED WITH THE WORK OF THIS SECTION.

A. Sections from Division 23000 – LON VAV Diffusers (Room)

B. Sections from Division 26000- Fire Alarm System.

1. Smoke Detectors (duct).

C. Section 26000 –Equipment and Motor Wiring.

1. Variable Frequency Drives
2. Power Monitoring System Control Units and Intelligent Devices.

1.7 SUBMITTALS.

A. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.

1. Each control device labeled with setting or adjustable range of control.

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. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
2. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.
3. Details of control panel faces, including controls, instruments, and labeling.
4. Written description of sequence of operation.
5. Schedule of dampers including size, leakage, and flow characteristics.
6. Schedule of valves including close-off and flow characteristics.
7. Trunk cable schematic showing programmable control unit locations and trunk data conductors.
8. Listing of connected data points, including connected control unit and input device.
9. System graphics indicating monitored systems, data (connected and calculated) point addresses, and operator notations.
10. System configuration showing peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.

C. External Interface Files: XIF files or object diagrams for each DDC system component (Custom Application Controller and Application Specific Controller) proposed.

D. Software and Firmware Operational Documentation: Include the following:

1. Engineering, Installation, Operation and Maintenance manuals.
2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.
5. Licenses, guarantee, and warranty documents for all equipment and systems.

E. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

F. Maintenance Data: For systems to include in maintenance manuals specified in Division 1.

Include the following:

1. Maintenance instructions and lists of spare parts for each type of control device and compressed air station.
2. Interconnection wiring diagrams with identified and numbered system components and devices.
3. Keyboard illustrations and step-by-step procedures indexed for each operator function.
4. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
5. Calibration records and list of set points.

G. Qualification Data: For firms and persons specified in "Quality Assurance" Article.

H. Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors. Revise Shop Drawings to reflect actual installation and operating sequences.

1.8 QUALITY ASSURANCE.

A. Important: Bids by wholesalers, distributors, mechanical contractors, ABCS, ACS, and non-franchised contractors shall not be acceptable. The intent of this is to ensure expertise, accountability, single point responsibility and the avoidance of conflict of interests with other divisions and contractors.

B. The system manufacturer shall, as a minimum, manufacture and supply the Custom Application Controller, Application Specific Controller, Unitary Equipment Controller, Advanced Application Controller, Graphical User Interface, damper actuators, and valve actuator assemblies., except where stated otherwise in this specification.

C. All work described in this section shall be installed, wired, circuit tested by qualified and certified electricians that are licensed journeymen or enrolled in a qualified electrician apprentice program and properly supervised according to state and local ordinances. Also work described in this section shall be calibrated by factory certified technicians qualified for this work and in the regular employment of the temperature control system manufacturer’s local field office.

D. The Building Management System contractor shall be Utah Yamas Controls and have a full service facility within 50 miles of the project that is staffed with engineers trained in Integrating Interoperable Systems and technicians fully capable of providing LonMark/LonWorks and/or BACnet instructions and routine emergency maintenance service on all system components.

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 90A, "Installation of Air Conditioning and Ventilation Systems.".

G. Comply with National Electric Code, UL-916 Energy Management Systems, LonMark™, ULC, FCC Part 15, subpart J, Class B Computing Devices.

H. Comply with EIA Standard 709.1 LonTalk™ protocol for DDC system control components.

1.9 DELIVERY, STORAGE AND HANDLING.

A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to unit manufacturer.

1.10 COORDINATION.

A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.

B. Coordinate equipment from other divisions including Motor-Control Centers," "Panelboards," and "Fire Alarm" to achieve compatibility with equipment that interfaces with those systems.

C. Coordinate supply of conditioned electrical circuits for control units and operator workstation.

D. Coordinate with the Owner's IT department on locations for AS, Ethernet communication cabling and TCP/IP addresses.

1.11 WARRANTY AND MAINTENANCE.

A. All components, system software, and parts furnished and installed by the BMS contractor shall be guaranteed against defects in materials and workmanship for 1 year of substantial completion. Labor to repair, reprogram, or replace these components shall be furnished by the BMS contractor at no charge during normal working hours during the warranty period. Materials furnished but not installed by the BMS contractor shall be covered to the extent of the product only. Installation labor shall be the responsibility of the trade contractor performing the installation. All corrective software modifications made during warranty periods shall be updated on all user documentation and on user and manufacturer archived software disks. The Contractor shall respond to the owner's request for warranty service within 1 day.

1.12 OWNERSHIP OF PROPRIETARY MATERIAL.

A. The owner shall sign a copy of the manufacturer’s standard software and firmware licensing agreement as a condition of this contract. Such license shall grant use of all programs and application software to owner as defined by the manufacturer’s license agreement, but shall pro-

tect manufacturer's rights to disclosure of trade secrets contained within such software. All project developed software and documentation shall become the property of the owner. These include, but are not limited to project graphic images, record drawings, project database, project specific application programming code, and all other associated documentation.

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS AND INSTALLING CONTRACTORS

A. TAC Schneider Electric I/A-Series StruxureWare as provided and installed by Utah Yamas Controls Inc. Point of contact Scott Porter 801-990-1950.

B. No other contractor or products acceptable for this project.

2.2 DDC EQUIPMENT

A. The Operator Work Station, Graphical User interface as well as the associated Web services are all existing. This contractor shall generate graphics depicting this remodel and all affected mechanical equipment. All new controllers shall be added to the existing communication trunk so that all building ATC functions can be viewed and managed from multiple locations on campus.

B. Network Controllers (Automation Servers) shall be StruxureWare and employ LON, BACnet and Modbus software and hardware architecture solution as the foundation for managing and facilitating all services, global and communication functions.

1. The Automation Server (AS) shall provide the interface between the LAN or WAN and the field control devices, and provide global supervisory control functions over the control devices connected to the AS. The AS shall connect with the compatible SUU StruxureWare Enterprise Server. It shall be capable of executing application control programs to provide:

   a. Calendar functions
   b. Scheduling
   c. Web service utilities
   d. Contain all DDC control programming and editing software
   e. Trending
   f. Alarm monitoring and routing
   g. Time synchronization by means of an Atomic Clock Internet site including automatic synchronization
   h. Integration of LonWorks controller data and BACnet controller data and Mod-Bus.
   i. Network Management functions for all LonWorks based devices

2. The (AS) must provide the following hardware features as a minimum:

a. One Ethernet Port – 10/100 Mbps
b. Two USB ports
c. Four RS-RS485 connections
d. LonWorks Interface Port
e. Operator Panel Interface
f. Power supply
g. 4 GB Memory
h. Real-time clock
i. Processor @ 160 MHz or greater
j. SDRAM 128MB

3. The AS shall provide multiple user access to the system and support. A database resident on the AS shall provide o read and write data stored within it.
4. The AS shall support standard Web browser access via the Intranet/Internet.
5. Event Alarm Notification and Actions

a. The StruxureWare system shall provide alarm recognition, storage; routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers.
b. The StruxureWare system shall be able to route any alarm condition to any defined user location whether connected to a local network or remote via dial-up telephone connection, or wide-area network.
c. Alarm generation shall be selectable for annunciation type and acknowledgement requirements including but limited to:

1) To alarm
2) Return to normal
3) To fault

d. Provide for the creation of a minimum of eight of alarm classes for the purpose of routing types and or classes of alarms, i.e.: security, HVAC, Fire, etc.
e. Provide timed (schedule) routing of alarms by class, object, group, or node.
f. Provide alarm generation from binary object “runtime” and /or event counts for equipment maintenance. The user shall be able to reset runtime or event count values with appropriate password control.
g. Control equipment and network failures shall be treated as alarms and annunciated.
h. Alarms shall be annunciated in any of the following manners as defined by the user:

1) Screen message text
2) Email of the complete alarm message to multiple recipients. Provide the ability to route and email alarms based on:

a) Day of week
b) Time of day
c) Recipient

3) Pagers via paging services that initiate a page on receipt of email message
4) Graphic with flashing alarm object(s)

5) Printed message, routed directly to a dedicated alarm printer

i. The following shall be recorded by the StruxureWare system for each alarm (at a minimum):

1) Time and date
2) Location (building, floor, zone, office number, etc.)
3) Equipment (air handler #, access way, etc.)
4) Acknowledge time, date, and user who issued acknowledgement.
5) Number of occurrences since last acknowledgement.

j. Alarm actions may be initiated by user defined programmable objects created for that purpose.
k. Defined users shall be given proper access to acknowledge any alarm, or specific types or classes of alarms defined by the user.
l. A log of all alarms shall be maintained by the StruxureWare system and/or a server (if configured in the system) and shall be available for review by the user.
m. Provide a “query” feature to allow review of specific alarms by user defined parameters.
n. A separate log for system alerts (controller failures, network failures, etc.) shall be provided and available for review by the user.
o. An Error Log to record invalid property changes or commands shall be provided and available for review by the user.

6. Data Collection and Storage

a. The StruxureWare system shall have the ability to collect data for any property of any object and store this data for future use.
b. The data collection shall be performed by log objects, resident in the StruxureWare system that shall have, at a minimum, the following configurable properties:

1) Designating the log as interval or deviation.
2) For interval logs, the object shall be configured for time of day, day of week and the sample collection interval.
3) For deviation logs, the object shall be configured for the deviation of a variable to a fixed value. This value, when reached, will initiate logging of the object.
4) For all logs, provide the ability to set the maximum number of data stores for the log and to set whether the log will stop collecting when full, or rollover the data on a first-in, first-out basis.
5) Each log shall have the ability to have its data cleared on a time-based event or by a user-defined event or action.

7. All log data shall be stored in a relational database in the StruxureWare system and the data shall be accessed from a server and a standard Web Browser.
8. All log data, when accessed from a server, shall be capable of being manipulated using standard statements.
9. All log data shall be available to the user in the following data formats:

a. HTML
b. XML
c. Plain Text
d. Comma or tab separated values

10. Systems that do not provide log data in HTML and XML formats at a minimum shall provide as an alternative Microsoft SQL Serverâ, Oracle 8i or Expressâ, Hyperion Solutions™ SQL Server.
11. The StruxureWare system shall have the ability to archive its log data either locally (to itself), or remotely to a server or other StruxureWare system on the network. Provide the ability to configure the following archiving properties, at a minimum:

    a. Archive on time of day
    b. Archive on user-defined number of data stores in the log (buffer size)
    c. Archive when log has reached it's user-defined capacity of data stores
    d. Provide ability to clear logs once archived

12. AUDIT LOG

    a. Provide and maintain an Audit Log that tracks all activities performed on the StruxureWare system. Provide the ability to specify a buffer size for the log and the ability to archive log based on time or when the log has reached it's user-defined buffer size. Provide the ability to archive the log locally or to a server. For each log entry, provide the following data:

        1) Time and date
        2) User ID
        3) Change or activity: i.e., Change setpoint, add or delete objects, commands, etc.

13. DATABASE BACKUP AND STORAGE

    a. The StruxureWare system shall have the ability to automatically backup its database. The database shall be backed up based on a user-defined time interval.
    b. Copies of the current database and, at the most recently saved database shall be stored in the AS. The age of the most recently saved database is dependent on the user-defined database save interval.
    c. The StruxureWare system database shall be stored, at a minimum, in XML format to allow for user viewing and editing, if desired. Other formats are acceptable as well, as long as XML format is supported.

C. Control Units General:

Control units, other than for the Workstation Server Software and Hardware as well as for any Universal Network Controllers, shall be based entirely upon the LonMark/LonWorks standards. Provide an adequate number of control units to achieve monitoring and control of all data points specified and necessary to satisfy the sequence of operation for all mechanical systems shown on the plans. Provide a minimum of one separate controller for each AHU or other HVAC system. Multiple DDC controllers may control one system provided that all

points associated with individual control loops are assigned to the same DDC controller. Points used for control loop reset such as outside air or space temperature are exempt from this requirement. Each of the following panel types shall meet the following requirements.

1. Controllers shall be suitable for the anticipated ambient conditions.

    a. Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures, and shall be rated for operation at -40°F to 140°F and 5 to 95% RH, non condensing.
    b. Controllers used in conditioned ambient space shall be mounted in dustproof enclosures, and shall be rated for operation at 32°F to 122°F and 5 to 95% RH, non condensing.

2. Serviceability: Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
3. Memory: The Control Units shall maintain all BIOS and programming information in the event of a power loss for at least 72 hours.
4. Diagnostics: The Building Controller shall continually check the status of its processor and memory circuits. If an abnormal operation is detected, the controller shall assume a predetermined failure mode and generate an alarm notification.
5. Immunity to power and noise: Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 3 ft.
6. Automatic staggered restart of field equipment after restoration of power and short cycle protection.

D. Custom Application Control Units:

Modular, comprising processor board with programmable, nonvolatile, RAM/EEPROM memory for custom control applications. CAC's shall be provided for Roof Top Units, Boiler Plant, Chiller Plant and other applications as shown on drawings and shall have published Lon-Works™ application source code, device resource files and external interface definitions.

1. Units monitor or control each input/output point; process information; and at least 50 expressions for customized HVAC control including mathematical equations, Boolean logic, PID control loops with anti-windup, sequencers, timers, interlocks, thermostats, enthalpy calculation, counters, interlocks, ramps, drivers, schedules, calendars, OSS, compare, limit, curve fit, and alarms.
2. Stand-alone mode control functions operate regardless of network status. Functions include the following:

    a. Peer to peer primary network level communications supporting at least 200 LonMark™ Standard Network Variables (SNVTs) per CAC utilizing at least 100 different SNVT types as documented by the LonMark™ Interoperability Association to assure present and future compatibility with third party LonMark™ devices. The 200

LonMark™ SNVTs, minimum, must be configurable in any combination – all inputs or all outputs or any combination of input/outputs in any combination of the 100 different, minimum, SNVT types. The XIF SNVT order shall be definable, rather than random, to provide logical and effective LonMark™ network management. With the submittal package, contractor shall provide CAC performance data that specifies the exact maximum number of SNVTs available in any combination and a list of all available SNVT types including the LonMark™ Interoperability Association SNVT number.

b. Automatic communications loss detection to maintain normal control functionality regardless of available network communications.
c. Discrete/digital, analog, and pulse input/outputs.
d. Monitoring, controlling, or addressing data points.
e. Local energy management control strategies
f. Incorporate internal customizable safeties and limits to prevent third party LonMark ™ tools from providing improper and unrealistic inputs to CAC's.

3. Local operator interface port provides for download from and connection to portable workstation.
4. Communication: The Custom Application Controller shall communicate via the Primary Controller Network between BMS Controllers and other LonWorks ™ devices. CAC's shall communicate with the Building Controller and ASC's at a baud rate of not less than 78.8 baud using LonWorks ™ communications protocol (EIA 709.1).

E. CAC Room Sensor

1. The CAC Sensor shall provide room temperature value to the CAC.
2. The CAC Sensor shall connect directly to the CAC and shall not utilize any of the I/O points of the controller.
3. The CAC Sensor shall provide a two-wire connection to the controller that is polarity and wire type insensitive.
4. The CAC Sensor shall be provided in a modular configuration that allows for the rough in of all wiring without the presence of the electronics or esthetic covering.
5. TheCAC Sensor shall be provided in a modular configuration that allows for the rough in of all wiring without the presence of the electronics or esthetic covering.
6. The CAC Sensor shall allow for the customization of the color on the esthetic covering as a standard offering.
7. The CAC Sensor shall be supplied in the following manner:

a. LCD display for showing (typically) the current temperature.
b. Tenant override to allow timed override of unoccupied to occupied mode of operation.
c. LED indication of override state.
d. Up/Down keys to allow adjustment of the current setpoint
e. User interface with the CAC Sensor shall be provided as a configurable function, and shall offer password protection for access to network variable editing.
f. ASHRAE 95 compliance (LCD display and sub-base functionality)
g. The room sensor shall provide access to additional diagnostic data from a sensor-user keypad request. This Diagnostic mode is displayed on the LCD screens and includes

separate displays for the controllers:

1) Subnet and Node Address
2) Errors
3) Alarms
4) Temperature Offset

F. Advanced Application Controller (AAC):

Modular, comprising processor board with programmable, nonvolatile, RAM/EEPROM memory for custom control applications. AAC's shall be provided for large AHU's, Boiler Plant, Chiller Plant and other applications as shown on drawings.

1. Units monitor or control each input/output point; process information; and at least 50 expressions for customized HVAC control including mathematical equations, Boolean logic, PID control loops with anti-windup, sequencers, timers, interlocks, thermostats, enthalpy calculation, counters, interlocks, ramps, drivers, schedules, calendars, OSS, compare, limit, curve fit, and alarms.

G. Application Specific Control Units:

Single board construction comprising processor board with programmable, nonvolatile, RAM/EEPROM memory for custom control and unitary applications. ASCs shall be provided for Unit Ventilators, Fan Coils, Heat Pumps, Rooftop Units, and other applications as shown on the drawings. To assure complete interoperability, all ASCs firmware shall support all mandatory and all optional LonMark™ Standard Network Variables (SNVTs) for their LonMark™ profile as documented by the LonMark™ Interoperability Association. Bidder shall provide proof of ASC compliance for all the mandatory and all optional LonMark™ SNVTs. ASCs shall be based on the Echelon Neuron 3150 microprocessor working with the ASCs stand alone control program.

1. Units monitor or control each input/output point; process information; and download from the operator station.
2. Stand-alone mode control functions operate regardless of network status. Functions include the following:

   a. Peer to peer primary network level communications with automatic communications loss detection to maintain normal control functionality regardless of available network communications.
   b. Discrete/digital, analog, and pulse input/output.
   c. Monitoring, controlling, or addressing data points.
   d. Appropriate LonMark™ profiles for specific unitary applications.
   e. Support for all mandatory and optional LonMark™ Standard Network Variable Types (SNVTs) for their LonMark™ profile as documented by the LonMark™ Interoperability Association
   f. Internal customizable safeties and limits to prevent third party LonMark™ tools from providing improper and unrealistic inputs to ASC's.

3. Local operator interface port located on ASC and ASC sensor provides for download from or upload to portable workstation. All Lon bus devices shall be accessible from either port.
4. Communication: ASC's shall communicate with the Building Controller and CAC's at a baud rate of not less than 78.8K baud using LonTalk™ communications protocol (EIA 709.1).
5. ASC units monitor or control each input/output point; process information; and at least 50 expressions for customized HVAC control including mathematical equations, boolean logic, PID control loops with anti-windup, sequencers, timers, interlocks, thermostats, counters, interlocks, compare, limit, and alarms.
6. All ASC Controller setpoints shall be digital display setpoints with dual setpoint limits (integral hard limits which the user cannot exceed above and below and independent soft limits which are hidden from the user). All digital setpoints shall be network retentive after power outages and after replacement of sensor.

H. ASC Room Sensor

1. The ASC Sensor shall provide room temperature value to the ASC.
2. The ASC Sensor shall connect directly to the ASC and shall not utilize any of the I/O points of the controller.
3. The ASC Sensor shall provide a two-wire connection to the controller that is polarity and wire type insensitive.
4. The ASC Sensor shall be provided in a modular configuration that allows for the rough in of all wiring without the presence of the electronics or esthetic covering.
5. The ASC Sensor shall be provided in a modular configuration that allows for the rough in of all wiring without the presence of the electronics or esthetic covering.
6. The ASC Sensor shall allow for the customization of the color on the esthetic covering as a standard offering.
7. The ASC Sensor shall be supplied in the following manner:

    a. LCD display for showing (typically) the current temperature.
    b. Tenant override to allow timed override of unoccupied to occupied mode of operation.
    c. LED indication of override state.
    d. Up/Down keys to allow adjustment of the current setpoint
    e. User interface with the ASC Sensor shall be provided as a configurable function, and shall offer password protection for access to network variable editing.
    f. ASHRAE 95 compliance (LCD display and sub-base functionality)
    g. The room sensor shall provide access to additional diagnostic data from a sensor-user keypad request. This Diagnostic mode is displayed on the LCD screens and includes separate displays for the controllers:

        1) Subnet and Node Address
        2) Errors
        3) Alarms
        4) Temperature Offset

I. Unitary Equipment Controller Units:

Single board construction comprising processor board with programmable, nonvolatile, RAM/EEPROM memory for custom control and unitary applications. ASCs shall be provided for Unit Ventilators, Fan Coils, Heat Pumps, Rooftop Units, and other applications as shown on the drawings.

1. The Unitary Equipment Controller shall have the following point count as a minimum.

    a. 6 Universal Inputs

        1) 0-20mA
        2) 0-5 VDC
        3) Balco Sensors
        4) Platinum Sensor
        5) 10K thermistor

    b. 4 Analog Outputs

        1) 0-20 mA
        2) 0-5/10 VDC
        3) Individually short circuit protected

    c. 8 Digital Outputs

        1) Triacs
        2) LED indication

2. Units monitor or control each input/output point; process information; and download from the operator station.
3. The controller shall have removable terminals for:

    a. 24 VAC Power inputs
    b. MS/TP Communication terminals

4. Stand-alone mode control functions operate regardless of network status. Functions include the following:

    a. Peer to peer primary network level communications with automatic communications loss detection to maintain normal control functionality regardless of available network communications.
    b. Discrete/digital, analog, and pulse input/output.
    c. Monitoring, controlling, or addressing data points.

5. Local operator interface port located on UEC and UEC sensor provides for download from or upload to portable workstation. All bus devices shall be accessible from either port.
6. Communication: UEC’s shall communicate with the AS and ACC at a baud rate selectable of 9.6-76.8 Kbaud utilizing MS/TP.
7. UEC units monitor or control each input/output point; process information; and at least

50 expressions for customized HVAC control including mathematical equations, Boolean logic, PID control loops with anti-windup, sequencers, timers, interlocks, thermostats, counters, interlocks, compare, limit, and alarms.

8. All UEC Controller setpoints shall be digital display setpoints with dual setpoint limits (integral hard limits which the user cannot exceed above and below and independent soft limits which are hidden from the user). All digital setpoints shall be network retentive after power outages and after replacement of sensor.

J. UEC Room Sensor

1. The UEC Sensor shall provide room temperature value to the controller.
2. Each UEC shall support a minimum of two sensors.
3. The UEC Sensor shall connect directly to the controller and shall not utilize any of the I/O points of the controller.
4. The UEC Sensor shall provide a two-wire connection to the controller that is polarity and wire type insensitive.
5. The UEC Sensor shall be provided in a modular configuration that allows for the rough in of all wiring without the presence of the electronics or esthetic covering.
6. The UEC Sensor shall allow for the customization of the color on the esthetic covering as a standard offering.
7. The UEC Sensor shall be supplied in the following manner:

    a. LCD display for showing (typically) the current temperature.
    b. Tenant override to allow timed override of unoccupied to occupied mode of operation.
    c. LED indication of override state.
    d. Up/Down keys to allow adjustment of the current setpoint
    e. User interface with the UEC Sensor shall be provided as a configurable function, and shall offer password protection for access to network variable editing.
    f. ASHRAE 95 compliance (LCD display and sub-base functionality)
    g. The room sensor shall provide access to additional diagnostic data from a sensor-user keypad request. This Diagnostic mode is displayed on the LCD screens and includes separate displays for the controllers:

        1) Subnet and Node Address
        2) Errors
        3) Alarms
        4) Temperature Offset

K. ASC – Fan Coil Unit, Unit Ventilator, Heat Pump, or Packaged Rooftop Controller Functionality.

Controls shall be microprocessor based as shown in the drawings or indicated in the sequence of operations. The ASC shall be a single integrated package consisting of a microprocessor, power supply, field terminations, and application software. The units shall be started and stopped from the BMS. A low limit protection thermostat in the mixed air section of the unit shall close down the outdoor air damper, open coil valves, and alarm the BMS when a temperature below 38°F (adjustable) is sensed. All input/output signals shall be directly

hardwired to the ASC controller. In all cases, the controller shall automatically resume proper operation following the return of power to, or control by the ASC.

1. All ASCs must have an operating temperature range -40°F to 140°F and 5 to 95% RH, non condensing because they are located in the proximity of extreme temperatures (hot water/steam pipes or the outdoor air.)
2. All ASCs shall have capability for both ASHRAE Cycle II and ASHRAE Cycle III fully tested and validated. Bidder shall provide application documentation for ASC ASHRAE cycle II and III compliance including sequence of operation, controller program, and available SNVT's. The control program shall also be fully customizable in the field to accommodate any local or project specific requirements that may be required.
3. All duct averaging sensors for ASCs must be true continuous averaging units that sense the mean temperature over the complete length of the sensor end to end. Sensors that provide four or nine sensing points, which may be accurate due to air temperature stratifications, are not acceptable.
4. All ASCs shall be easily replaceable for ease of future maintenance and to minimize downtime.
5. The outputs of the ASC shall be of the relay Form C and universal analog form. All digital outputs shall be relay type Form C. ASC devices utilizing non-relay outputs shall provide an interface relay for all points. All analog outputs shall be programmable for their start points and span to accommodate the control devices.

L. LANs:

Capacity for a minimum of 64 client workstations connected to multi-user, multitasking environment with concurrent capability to access DDC network or control units.

1. Enterprise Network LAN

   a. Media: Ethernet (IEEE 802.3), peer-to-peer CSMA/CD, operating at 10 or 100 Mbps, cable 10 Base-T, UTP-8 wire, category 5

2. Primary Controller Network LAN

   a. Media: LonTalk™ (EIA 709.1), peer to peer, FTT-10 operating at 78.8K.

3. Secondary Network LAN (If Required)

   a. Media: LonTalk™ (EIA 709.1), peer to peer, FTT-10 operating at 78.8K

4. Remote Connection

   a. ISDN, ADSL, T1 or dial-up connection, monthly charges paid by building owner

M. Software: Existing

2.3 CONTROL PANELS

A. Local Control Panels: Unitized NEMA 1 cabinet with suitable brackets for wall or floor mounting, located adjacent to each system under automatic control. Provide common keying for all panels.

1. Fabricate panels 0.06-inch thick, furniture-quality steel, or extruded-aluminum alloy, totally enclosed, with hinged doors and keyed lock and with manufacturer's standard shop-painted finish.
2. Interconnections between internal and face-mounted devices pre-wired with color-coded stranded conductors neatly installed in plastic troughs and/or tie-wrapped. Terminals for field connections shall be UL Listed for 600 volt service, individually identified per control/interlock drawings, with adequate clearance for field wiring. Control terminations for field connection shall be individually identified per control drawings.
3. Door-Mounted Equipment: Flush-mount (on hinged door) manual switches, including damper-positioning switches, changeover switches, thermometers, and gauges.
4. Provide ON/OFF power switch with over-current protection for control power sources to each local panel.

2.4 SENSORS

A. Electronic Temperature Sensors: Vibration and corrosion resistant for wall, immersion, or duct mounting as required.

1. Resistance Temperature Detectors: Platinum, thermistor, or balco

a. Accuracy: Plus or minus 0.2 percent at calibration point; thermistors shall have a maximum 5 year drift of no more than .225°F maximum error of no more than .36°F
b. Wire: Twisted, shielded-pair cable
c. Insertion Elements in Ducts: Single point, 6 inches long; use where not affected by temperature stratification or where ducts are smaller than 4 sq. ft.
d. Averaging Elements in Ducts: 60 inches, long, flexible for use where prone to temperature stratification or where ducts are larger than 4 sq. ft.; 264 inches long, flexible for use where prone to temperature stratification or where ducts are larger than 16 sq. ft; length as required.
e. Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches.
f. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
g. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.

2. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.

a. Accuracy: +/- 1 percent of full scale with repeatability of 0.5 percent.
b. Output: 4 to 20 mA, 0-5 vDC, 0-10 vDC.
c. Building Static-Pressure Range: -.1 to .1, -0.25 to 0.25, -.5 to .5, -1.0 to 1.0 IN WC., jumper selectable.
d. Duct Static-Pressure Range: 0 to 1, 0 to 2.5, 0 to 5, 0 to 10 IN WC., jumper adjusta-

ble.

3. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; proportional output 4 to 20 mA.

B. Equipment operation sensors as follows:

1. Status Inputs for Fans: Differential-pressure switch with adjustable range of 0 to 5 IN WC.
2. Status Inputs for Pumps: Differential-pressure switch piped across pump with adjustable pressure-differential range of 8 to 60 psig.
3. Status Inputs for Electric Motors: Current-sensing relay with current transformers, adjustable and set to 175 percent of rated motor current.

C. Electronic Valve/Damper Position Indication: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.

D. Carbon-Dioxide Sensor and Transmitter: Single detectors, using solid-state infrared sensors, suitable over a temperature range of 23°F to 130°F, calibrated for 0 to 2 percent, with continuous or averaged reading, 4 to 20 mA output, and wall mounted.

2.5 THERMOSTATS

A. Electric Low-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or below set point.

1. Bulb Length: Minimum 20 feet
2. Quantity: One thermostat for every 20 sq. ft. of coil surface.

B. BTU Meters: Each BTU measurement system is individually calibrated using application specific flow and temperature data and is provided with calibration certifications. Must have an accuracy better than ±0.15° F over calibrated range at the calibrated typical flow rate and within ±2% of rate over an extended 50:1 turndown range (0.4 - 20 ft/s). All mechanical installation hardware, color coded interconnecting cabling and installation instructions are provided to ensure error-free installation and accurate system performance. Meter must provide highly accurate thermal energy measurement in chilled water, hot water and condenser water systems based on signal inputs from two matched temperature sensors. The BTU Meter will support the following applications:

• University campus monitoring
• Institutional energy cost allocation
• Performance/efficiency evaluations
• Performance contracting energy monitoring

C. Acceptable manufacturer: Onicon

2.6 ACTUATORS

A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action under all environmental conditions (temperature, low power voltage fluctuations, tight seal damper design, maximum air and water flow forces).

1. 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.
2. Nonspring-Return Motors for Valves Larger Than NPS 2-1/2”: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
3. Spring-Return Motors for Valves Larger Than NPS 2-1/2”: Size for running and breakaway torque of 150 in. x lbf.
4. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
5. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running and breakaway torque of 150 in. x lbf.

B. Electronic Damper and Valve Actuators: Direct-coupled type non-hydraulic designed for minimum 100,000 full-stroke cycles at rated torque. The actuator shall have rating of not less than twice the thrust needed for actual operation of the damper or valve

1. Coupling: V-bolt and V-shaped, toothed cradle.
2. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
3. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on non-spring-return actuators.
4. Actuators shall have the ability to be tandem mounted.
5. All spring-return actuators shall have a manual override. Complete manual override shall take no more than 10 turns.
6. Power Requirements (Two-Position Spring Return): 24V ac or dc, Maximum 10VA.
7. Power Requirements (Modulating): Maximum 15 VA at 24V ac.
8. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
9. Temperature Rating: -22°F to 140ºF.
10. Run Time: 200 seconds open, 40 seconds closed.
11. All actuators shall have a 5-year warranty.
12. Valves:

    a. Size for torque required for valve close-off at maximum pump differential pressure (regardless of water loop system pressures).
    b. Valve and Actuators shall come from the factory fully assembled.
    c. Spring Return Manual Override shall come with a 10 Degree Valve Preload to assure tight close off.

13. Dampers:

a. Size for running torque calculated as follows:

1) Parallel-Blade Damper with Edge Seals: 7 inch-pounds/sq. ft. of damper.
2) Opposed-Blade Damper with Edge Seals: 5 inch-pounds/sq. ft. of damper.
3) Parallel-Blade Damper without Edge Seals: 4 inch-pounds/sq. ft. damper.
4) Opposed-Blade Damper without Edge Seals: 3 inch-pounds/sq. ft. of damper.
5) Dampers with 2 to 3 Inches wg. of Pressure Drop or Face Velocities of 1000 to 2500 FPM Multiply the minimum full-stroke cycles above by 1.5.
6) Dampers with 3 to 4 Inches wg. of Pressure Drop or Face Velocities of 2500 to 3000 FPM Multiply the minimum full-stroke cycles above by 2.0.

b. Spring Return Manual Override actuators shall have a factory set 5 Degree Damper Preload.

2.7 CONTROL VALVES

A. Control Valves: Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.

B. Globe Valves NPS 2” and Smaller: Bronze body, bronze trim, rising stem, renewable composition disc, and screwed ends with backseating capacity repackable under pressure. Valves shall have allowable media temperature of 20°F to 281°F to assure that the valve packing will have a long life (valves with narrower allowable media temperatures have no reserve packing capability for long term watertight seal.)

C. Hydronic system globe valves shall have the following characteristics :

1. Rating: Class 125 for service at 125 psig. and 250°F operating conditions.
2. Internal Construction: Replaceable plugs and seats of stainless steel or brass.

a. Single-Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom of guided plugs.
b. Double-Seated Valves: Balanced plug; cage trim provides seating and guiding surfaces for plugs on top and bottom of guided plugs.

3. Sizing: 3 psig. maximum pressure drop at design flow rate.
4. Temperature Requirements: Valve and actuator assembly shall be able to operate in ambient temperatures of -22°F to 140°F.
5. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics. Operators shall close valves against pump shutoff head.
6. Product Life: Valve and actuator assembly shall be rated for a minimum of 200,000 cycles and tested for close off prior to delivery.

D. Control Ball Valves NPS 3” and smaller (NPS 2” for 3-way valves): Forged brass body (CuZn39Pb2), chrome plated brass ball and blowout proof stem and EPDM o-rings with minimum 600 psig. rating. Valve shall contain glass filled ball insert capable of providing equal

percentage flow. Valves shall have allowable media temperature of -20°F to 250°F.

1. Rating: No less than 360 psig. at 250°F operating conditions.
2. Rangeability: 2-way valves shall have a rangeability of at least 75:1
3. Medium: Valves shall be used with hot water or cold water with up to 50% glycol.
4. Temperature Requirements: Valve and actuator assembly shall be able to operate in ambient temperatures of -22°F to 140°F.
5. Sizing:

    a. Minimum 100 psig. close off on 2 way valves and 70 psig. on three way valves
    b. Maximum differential shall be 35 psig. to ensure quiet operation.

6. Flow Characteristics: 2 way valves shall have equal percentage characteristics. 3 way valves shall have an equal percentage characteristic through the control port and a linear characteristic through the bypass port.
7. Product Life: Valve and actuator assembly shall be rated for a minimum of 200,000 cycles and tested for close off prior to delivery.

E. Terminal Unit Control Valves: 360 psig. forged yellow brass body, nickel plated brass ball, with optimizer insert for modulating applications, blow-out resistant stem, two or three-port as indicated, and threaded ends for chilled or hot water, up to 50% glycol solutions. Actuators shall be as noted above with 5 year warranty. Spring return is required for all Unit Ventilator heating valves and other terminal equipment that has an outside air source. All non-spring return valves must have manual override ability built in to the actuator.

1. Rating: ANSI class IV, maximum static pressure of 250 psig ., minimum fluid temperature of 20ºF. and maximum of 250ºF operating conditions.
2. Sizing: 4 psig. maximum pressure drop at design flow rate, to close against pump shutoff head.
3. Flow Characteristics: Two-way and three-valves shall have equal percentage characteristics.

2.8 DAMPERS

A. Dampers: AMCA-rated, parallel, opposed blade designs; 0.1084 inch minimum, galvanized-steel frames with holes for duct mounting; damper blades shall not be less than 0.0635 inch galvanized steel with maximum blade width of .8 inches.

1. Blades shall be secured to 1/2-inch diameter, zinc-plated axles using zinc-plated hardware, with nylon blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
2. Operating Temperature Range: -40°F to 200°F
3. For standard applications, include optional closed-cell neoprene edging.
4. For low-leakage applications, use parallel- or opposed-blade design with inflatable seal blade edging, or replaceable rubber seals, rated for leakage at less than 10 cfm per sq. ft. of damper area, at differential pressure of 4 inches wg. when the damper is being held by

torque of 50 in. x lbf; when tested according to AMCA 500D.

2.9 CONTROL CABLE

A. Electronic and Fiber-Optic Cable for Control Wiring: As specified in Division 16 Section "Control/Signal Transmission Media." SUU required 100% ¾” conduit for all Automatic Temperature Control wiring.

B. LON communication cable shall be category 4.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that conditioned power supply is available to control units and operator workstation.

B. Verify that duct, pipe, and equipment mounted devices and wiring are installed before proceeding with installation.

3.2 INSTALLATION

A. Install equipment level and plumb.

B. Install software in control units and operator workstation. Implement all features of programs to specified requirements and as appropriate to sequence of operation.

C. Connect and configure equipment and software to achieve sequence of operation specified.

D. Verify location of thermostats and other exposed control sensors with plans and room details before installation. Locate all 60 inches above the floor.

1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.

E. Install guards or tamper proof enclosures on thermostats in the following locations:

1. Entrances.
2. Public areas.
3. Where indicated.

F. Coordinate Installation of automatic dampers according to Division 23000 Section "Duct Accessories.

G. Installation of damper actuators on outside of duct in warm areas, not in locations exposed to outdoor temperatures.

H. Install labels and nameplates to identify control components according to Division 23000 Section "Basic Mechanical Materials and Methods."

I. Install labels and nameplates to identify control components according to Division 23000 Section "Mechanical Identification."

J. Coordinate Installation of hydronic instrument wells, valves, and other accessories according to Division 23000 Section "Hydronic Piping."

K. Coordinate Installation of duct volume-control dampers according to Division 23000 Sections specifying air ducts.

L. Install electronic and fiber-optic cables according to Division 26000 Section "Control/Signal Transmission Media."

3.3 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. Install raceways, boxes, and cabinets according to Division 26000 Section "Raceways and Boxes."

B. Install building wire and cable according to Division 26000 Section "Conductors and Cables."

C. Install signal and communication cable according to Division 26000 Section "Control/Signal Transmission Media."

1. Cable may be installed in plenums where reasonable access is available as allowed by the National Electrical Code and local area codes.
2. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
3. Install exposed cable in raceway.
4. Install concealed and inaccessible cable in raceway.
5. Bundle and harness multi-conductor instrument cable in place of single cables where several cables follow a common path.
6. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
7. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.

D. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.

E. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Division 23000 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

   1. Install piping adjacent to machine to allow service and maintenance.

B. Ground equipment.

   1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections.

B. Replace damaged or malfunctioning controls and equipment.

   1. Start, test, and adjust control systems.
   2. Demonstrate compliance with requirements, including calibration and testing, and control sequences.
   3. Adjust, calibrate, and fine tune circuits and equipment to achieve sequence of operation specified.

C. Verify DDC as follows:

   1. Verify software including automatic restart, control sequences, scheduling, reset controls, and occupied/unoccupied cycles.
   2. Verify operation of operator workstation.
   3. Verify local control units including self-diagnostics.

3.6 ON-SITE ASSISTANCE

A. Occupancy Adjustments: Within one year of date of Substantial Completion, provide two Project site visits, as scheduled by Owner, to adjust and calibrate components and to assist Owner's personnel in making program changes and in adjusting sensors and controls to suit actual conditions for one visit addressing summer specific sequences and operations and one visit addressing winter specific sequences and operations. Each site visit will consist of no more than 8 hours not to exceed a total of 16 hours.

3.7 TRAINING

A. Provided as indicated above, provide a minimum of 24 hours of on-site or classroom training throughout the contract period for personnel designated by the Owner. Each session shall be a

minimum of four hours in length and must be coordinated with the building Owner. Train the designated staff of Owners Representative and Owner to enable them to:

1. Proficiently operate the system
2. Understand control system architecture and configuration
3. Understand DDC system components
4. Understand system operation, including DDC system control and optimizing routines (algorithms)
5. Operate the workstation and peripherals
6. Log on and off the system
7. Access graphics, point reports, and logs
8. Adjust and change system set points, time schedules, and holiday schedules
9. Recognize malfunctions of the system by observation of the printed copy and graphical visual signals
10. Understand system drawings, and Operation and Maintenance manual
11. Understand the job layout and location of control components
12. Access data from DDC controllers
13. Operate portable operators terminals

PART 4 - SEQUENCE OF OPERATION

4.1 GENERAL:

A. The over all intent of this project is to provide a complete DDC System that is seamlessly compatible (not via translation panels or integration devices) with the existing campus TAC-IA Lon control system. This system shall include all programming, installation, controllers, panels and related control devices required for a complete DDC system. Variable Frequency Drives with Lon cards will be furnished and installed by the electrical contractor. This contractor will directly communicate to the VFD’s via Lon talk. The overall functionality and quality of workmanship will meet the existing campus standard as well as DFCM standard for “High Performance Buildings.

END OF SECTION

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 specialties.
3. Piping and tubing joining materials.
4. Valves.
5. Pressure regulators.
6. Mechanical sleeve seals.
7. Grout.
8. Concrete bases.
9. This division is to pay all costs associated with the gas meter that are required by the local gas company/authority.

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 Pressures within Buildings: Two pressure ranges. Primary pressure is more than 2 psig but not more than 5 psig, and is reduced to secondary pressure of more than 0.5 psig but not more than 2 psig.

C. Delegated Design: Design restraints and anchors for natural-gas piping and equipment, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

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.
5. Mechanical sleeve seals.
6. Escutcheons.

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.

C. Delegated-Design Submittal: For natural-gas piping and equipment 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 seismic restraints.
2. Design Calculations: Calculate requirements for selecting seismic restraints.

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. Site Survey: Plans, drawn to scale, on which natural-gas piping is shown and coordinated with other services and utilities.

F. Qualification Data: For qualified professional engineer.

G. Welding certificates.

H. Field quality-control reports.

I. 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.

D. Protect stored PE pipes and valves from direct sunlight.

1.8 COORDINATION

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

B. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces. Comply with requirements in Division 08 Section "Access Doors and Frames."

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 PIPING SPECIALTIES

A. Appliance Flexible Connectors:

1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
3. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
4. Corrugated stainless-steel tubing with polymer coating.
5. Operating-Pressure Rating: 0.5 psig.
6. End Fittings: Zinc-coated steel.
7. Threaded Ends: Comply with ASME B1.20.1.
8. Maximum Length: 72 inches.

B. Quick-Disconnect Devices: Comply with ANSI Z21.41.

1. Copper-alloy convenience outlet and matching plug connector.
2. Nitrile seals.
3. Hand operated with automatic shutoff when disconnected.
4. For indoor or outdoor applications.
5. Adjustable, retractable restraining cable.

C. 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**] [**60**]-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

D. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.3 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for 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.

2.4 MANUAL GAS SHUTOFF VALVES

A. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.

1. CWP Rating: 125 psig.
2. Threaded Ends: Comply with ASME B1.20.1.
3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
6. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.

B. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with ASME B16.38.

1. CWP Rating: 125 psig.
2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
3. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
4. Service Mark: Initials "WOG" shall be permanently marked on valve body.

C. One-Piece, Bronze Ball Valve with Bronze Trim: MSS SP-110.

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

a. BrassCraft Manufacturing Company; a Masco company.
b. Conbraco Industries, Inc.; Apollo Div.
c. Lyall, R. W. & Company, Inc.
d. McDonald, A. Y. Mfg. Co.
e. Perfection Corporation; a subsidiary of American Meter Company.

2. Body: Bronze, complying with ASTM B 584.
3. Ball: Chrome-plated brass.
4. Stem: Bronze; blowout proof.
5. Seats: Reinforced TFE; blowout proof.
6. Packing: Separate packnut with adjustable-stem packing threaded ends.
7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
8. CWP Rating: 600 psig.
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

D. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.

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

   a. BrassCraft Manufacturing Company; a Masco company.
   b. Conbraco Industries, Inc.; Apollo Div.
   c. Lyall, R. W. & Company, Inc.
   d. McDonald, A. Y. Mfg. Co.
   e. Perfection Corporation; a subsidiary of American Meter Company.

2. Body: Bronze, complying with ASTM B 584.
3. Ball: Chrome-plated bronze.
4. Stem: Bronze; blowout proof.
5. Seats: Reinforced TFE; blowout proof.
6. Packing: Threaded-body packnut design with adjustable-stem packing.
7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
8. CWP Rating: 600 psig.
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

E. Two-Piece, Regular-Port Bronze Ball Valves with Bronze Trim: MSS SP-110.

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

   a. BrassCraft Manufacturing Company; a Masco company.
   b. Conbraco Industries, Inc.; Apollo Div.
   c. Lyall, R. W. & Company, Inc.
   d. McDonald, A. Y. Mfg. Co.
   e. Perfection Corporation; a subsidiary of American Meter Company.

2. Body: Bronze, complying with ASTM B 584.
3. Ball: Chrome-plated bronze.

4. Stem: Bronze; blowout proof.
5. Seats: Reinforced TFE.
6. Packing: Threaded-body packnut design with adjustable-stem packing.
7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
8. CWP Rating: 600 psig.
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

F. Bronze Plug Valves: MSS SP-78.

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

G. Cast-Iron, Nonlubricated Plug Valves: MSS SP-78.

   a. McDonald, A. Y. Mfg. Co.
   b. Mueller Co.; Gas Products Div.
   c. Xomox Corporation; a Crane company.

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.

H. Cast-Iron, Lubricated Plug Valves: MSS SP-78.

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

2.5 EARTHQUAKE VALVES

A. Earthquake Valves: Comply with ASCE 25.

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

    a. Vanguard Valves, Inc.

2. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction.
3. Maximum Operating Pressure: 5 psig.
4. Cast-aluminum body with nickel-plated chrome steel internal parts.
5. Nitrile-rubber valve washer.
6. Sight windows for visual indication of valve position.
7. Threaded end connections complying with ASME B1.20.1.
8. Wall mounting bracket with bubble level indicator.

B. Earthquake Valves: Comply with ASCE 25.

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

    a. Pacific Seismic Products, Inc.

2. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction.

3. Maximum Operating Pressure: [0.5 psig] [7 psig] [60 psig].
4. Cast-aluminum body with stainless-steel internal parts.
5. Nitrile-rubber, reset-stem o-ring seal.
6. Valve position, open or closed, indicator.
7. Composition valve seat with clapper held by spring or magnet locking mechanism.
8. Level indicator.
9. End Connections: Threaded for valves NPS 2 and smaller; flanged for valves NPS 2-1/2 and larger.

2.6 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; flanged for regulators NPS 2-1/2 and larger.

B. Line Pressure Regulators: Comply with ANSI Z21.80.

1. Manufacturers: Subject to compliance with requirements, provide products by one of 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: 5 psig.

2.7 DIELECTRIC FITTINGS

A. Dielectric Unions:

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

   a. Capitol Manufacturing Company.
   b. Central Plastics Company.
   c. Hart Industries International, Inc.
   d. 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-Flange Kits:

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

   a. Advance Products & Systems, Inc.
   b. Calpico Inc.
   c. Central Plastics Company.
   d. Pipeline Seal and Insulator, Inc.

2. Minimum Operating-Pressure Rating: 150 psig.
3. Companion-flange assembly for field assembly.
4. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or PE bolt sleeves, phenolic washers, and steel backing washers.
5. Insulating materials suitable for natural gas.
6. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

2.8 SLEEVES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

2.9 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

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

   a. Advance Products & Systems, Inc.
   b. Calpico Inc.
   c. Metraflex Company (The).
   d. Pipeline Seal and Insulator, Inc.

2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe and sleeve.
3. Pressure Plates: Stainless steel.
4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one nut and bolt for each sealing element.

2.10 ESCUTCHEONS

A. General Requirements for Escutcheons: Manufactured wall and ceiling escutcheons and floor plates, with ID to fit around pipe or tube, and OD that completely covers opening.

B. One-Piece, Deep-Pattern Escutcheons: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Escutcheons: With set screw.

1. Finish: Polished chrome-plated or rough brass.

D. Split-Casting, Cast-Brass Escutcheons: With concealed hinge and set screw.

1. Finish: Polished chrome-plated or rough brass.

E. One-Piece, Stamped-Steel Escutcheons: With set screw or spring clips and chrome-plated finish.

F. Split-Plate, Stamped-Steel Escutcheons: With concealed hinge, set screw or spring clips, and chrome-plated finish.

G. One-Piece, Floor-Plate Escutcheons: Cast-iron floor plate.

H. Split-Casting, Floor-Plate Escutcheons: Cast brass with concealed hinge and set screw.

2.11 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

2.12 LABELING AND IDENTIFYING

A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for 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 the International Fuel Gas Code to determine that natural-gas utilization devices are turned off in piping section affected.

C. Comply with the International Fuel Gas Code requirements for prevention of accidental ignition.

3.3 INDOOR PIPING INSTALLATION

A. Comply with the International Fuel Gas Code 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. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.

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

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

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

G. Locate valves for easy access.

H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.

I. Install piping free of sags and bends.

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

K. Install escutcheons at penetrations of interior walls, ceilings, and floors.

1. New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
b. Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
c. Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
d. Piping at Ceiling Penetrations in Finished Spaces: One-piece or split-casting, cast-brass type with polished chrome-plated finish.
e. Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge and set screw.
f. Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated finish.
g. Piping in Unfinished Service Spaces: One-piece, stamped-steel type with set screw or spring clips.
h. Piping in Equipment Rooms: One-piece, cast-brass type.
i. Piping in Equipment Rooms: One-piece, stamped-steel type with set screw or spring clips.
j. Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

L. 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 in Division 07 Section "Penetration Firestopping."

M. Verify final equipment locations for roughing-in.

N. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.

O. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.

1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.

P. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.

Q. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.

R. Concealed Location Installations: Except as specified below, install concealed natural-gas piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints as described in Part 2. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.

1. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.
2. In Floors: Install natural-gas piping with welded or brazed joints and protective coating in cast-in-place concrete floors. Cover piping to be cast in concrete slabs with minimum of 1-1/2 inches of concrete. Piping may not be in physical contact with other metallic structures such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quick-set additives or cinder aggregate.
3. In Floor Channels: Install natural-gas piping in floor channels. Channels must have cover and be open to space above cover for ventilation.
4. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.

    a. Exception: Tubing passing through partitions or walls does not require striker barriers.

5. Prohibited Locations:

    a. Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
    b. Do not install natural-gas piping in solid walls or partitions.

S. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

T. Connect branch piping from top or side of horizontal piping.

U. 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.

V. Do not use natural-gas piping as grounding electrode.

W. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.

X. Install pressure gage upstream and downstream from each line regulator. Pressure gages are specified in Division 23 Section "Meters and Gages for HVAC Piping."

3.4 VALVE INSTALLATION

A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.

B. Install underground valves with valve boxes.

C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

D. Install earthquake valves aboveground outside buildings according to listing.

E. Install anode for metallic valves in underground PE piping.

3.5 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. 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.

D. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.

3.6 HANGER AND SUPPORT INSTALLATION

A. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

B. Comply with requirements for pipe hangers and supports specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

C. 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.

3.7 CONNECTIONS

A. Connect to utility's gas main according to utility's procedures and requirements.

B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.

C. Install piping adjacent to appliances to allow service and maintenance of appliances.

D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.

E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.8 LABELING AND IDENTIFYING

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

B. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.9 PAINTING

A. Comply with requirements in Division 09 painting Sections for painting interior and exterior natural-gas piping.

B. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.

1. Alkyd System: MPI EXT 5.1D.

a. Prime Coat: Alkyd anticorrosive metal primer.
b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
c. Topcoat: Exterior alkyd enamel (semigloss).
d. Color: Gray.

C. Paint exposed, interior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.

1. Latex Over Alkyd Primer System: MPI INT 5.1Q.

a. Prime Coat: Quick-drying alkyd metal primer.
b. Intermediate Coat: Interior latex matching topcoat.
c. Topcoat: Interior latex (flat).
d. Color: Gray.

2. Alkyd System: MPI INT 5.1E.

a. Prime Coat: Quick-drying alkyd metal primer.
b. Intermediate Coat: Interior alkyd matching topcoat.
c. Topcoat: Interior alkyd (flat).
d. Color: Gray.

D. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.10 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.

4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Use 3000-psig 28-day, compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete."

3.11 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Test, inspect, and purge natural gas according to the International Fuel Gas Code 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 DEMONSTRATION

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

3.13 INDOOR PIPING SCHEDULE

A. Aboveground, piping NPS 2 and smaller shall be the following:

1. Steel pipe with wrought-steel fittings and welded or threaded joints.

B. Aboveground, piping NPS 2-1/2" and larger shall be the following:

1. Steel pipe with wrought-steel fittings and welded joints.

C. Underground, below building, piping shall be the following:

1. Steel pipe with wrought-steel fittings and welded joints in a vented conduit.

D. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

E. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

3.14 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Valves for pipe sizes NPS 2 and smaller at service meter shall be one of the following:

1. One-piece, bronze ball valve with bronze trim.
2. Bronze plug valve.

B. Valves for pipe sizes NPS 2-1/2 and larger at service meter shall be one of the following:

1. Bronze plug valve.
2. Cast-iron, nonlubricated 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. Section includes pipe and fitting materials and joining methods for the following:

1. Hot-water heating piping.
2. Chilled-water piping.
3. Makeup-water piping.
4. Condensate-drain piping.
5. Air-vent piping.
6. Dielectric fittings.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of the following:

1. Steel pipe and fittings.
2. Copper pipe, tubing and fittings.
3. Dielectric fittings.

B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.
2. Laboratory Test Reports for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation indicating that products comply with the testing and product requirements of the California Department of Public Health's (formerly, the California Health Services') "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

C. Delegated-Design Submittal:

1. Design calculations and detailed fabrication and assembly of pipe anchors and alignment guides, hangers and supports for multiple pipes, expansion joints and loops, and attachments of the same to the building structure.

2. Locations of pipe anchors and alignment guides and expansion joints and loops.
3. Locations of and details for penetrations, including sleeves and sleeve seals for exterior walls, floors, basement, and foundation walls.

1.4 INFORMATIONAL SUBMITTALS

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

1. Suspended ceiling components.
2. Other building services.
3. Structural members.

B. Qualification Data: For Installer.

C. Welding certificates.

D. Field quality-control reports: Written reports as specified in Part 3 of this section including:

1. Test procedures used.
2. Test results showing compliance with specified requirements.
3. Failed test results with corrective action taken to achieve compliance with specified requirements.

1.5 QUALITY ASSURANCE

A. Steel Support Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

1. Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. All grooved joint couplings, fittings, valves and specialties shall be the products of a single manufacturer.

1. All castings used for coupling housings, fittings, and valve bodies shall be date stamped for quality assurance and traceability.

1.6 COORDINATION

A. Coordinate layout and installation of hydronic piping and suspension system components with other construction, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

B. Coordinate pipe sleeve installations for foundation wall penetrations.

C. Coordinate piping installation with roof curbs, equipment supports, and roof penetrations. Roof specialties are specified in Division 7 Sections.

D. Coordinate pipe fitting pressure classes with products specified in related sections.

E. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into base. Concrete, reinforcement, and formwork requirements are specified in Division 3 Sections.

F. Coordinate installation of pipe sleeves for penetrations through exterior walls and floor assemblies. Coordinate with requirements for firestopping specified in Division 7 Section "Through-Penetration Firestop Systems" for fire and smoke wall and floor assemblies.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. **Drawn-Temper Copper Tubing**: **ASTM B 88, Type L**.

2.2 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53, black steel with plain ends; welded and seamless, Grade B, and wall thickness as indicated in "Piping Applications" Article.

B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in "Piping Applications" Article.

C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in "Piping Applications" Article.

D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in "Piping Applications" Article.

E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in "Piping Applications" Article.

F. Wrought-Steel Fittings: ASTM A 234, wall thickness to match adjoining pipe.

G. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

1. Material Group: 1.1.
2. End Connections: Butt welding.
3. Facings: Raised face.

H. Forged Steel "Olet" Type Fittings, Welding, Socket-Welding and Threaded: ASME B16.11 and ASTM A105.

1. 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.

I. Grooved Mechanical-Joint Fittings and Couplings:

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

   a. Victaulic Company.
   b. Anvil International, Inc.
   c. Tyco-Grinnel

2. Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 53, Type F, E, or S, Grade B factory-fabricated steel; or ASTM A 234, Grade WPB steel fittings with grooves or shoulders designed and constructed to accept grooved-end couplings.
3. Couplings: Two Ductile- housing and synthetic rubber gasket of central cavity pressure-responsive design; with ASTM A449 electroplated steel nuts and bolts to secure grooved pipe and fittings. Couplings shall comply with ASTM F1476 Standard Specification for the Performance of Gasketed Mechanical Couplings for Use in Piping Applications.
   a. Rigid Type: Coupling housings shall be cast with offsetting, angle-pattern bolt pads to provide joint rigidity and support and hanging in accordance with ANSI B31.1 and B31.9. [**OR**]
   b. Rigid Type: Coupling housings shall be cast with flat-pattern bolt pads to provide joint rigidity and support and hanging in accordance with ANSI B31.1 and B31.9. Install per manufacturer's instructions including tightening nuts to torque as outlined in manufacturer's instructions. Torque wrench must be used for accurate assembly to obtain specified performance.
   c. Gasket: High temperature EPDM gasket, suitable for water service to +250 deg F, without use of special lubricants. [**OR**]
   d. Gasket: High temperature EPDM gasket, suitable for water service to +250 deg F, with the use of extreme temperature lubricant. Install per manufacturer's recommendations including lubricating gasket inside and out.
   e. Flexible Type: For use in locations where vibration attenuation and stress relief are required, and for the elimination of flexible connectors.
   f. 14" and Larger: Two –segment coupling, with lead-in chamfer on housing key and a wide-width gasket having a center-leg.
4. Combinations of grooved mechanical-joint couplings and short nipples may also be used.

J. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.

2.3 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch (3.2-mm) maximum thickness unless otherwise indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Solder Filler Metals: ASTM 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 D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 DIELECTRIC FITTINGS

A. General: Assembly or fitting with insulating material isolating joined dissimilar metals, to prevent galvanic action and stop corrosion.

1. Manufacturers:
a. Advance Products & Systems, Inc.
b. Calpico, Inc.Capitol Manufacturing Co.
c. Capitol Manufacturing Company.
d. Central Plastics Company.
e. Elster Perfection.
f. Grinnell Mechanical Products.
g. Matco-Norca.
h. Pipeline Seal and Insulator, Inc.
i. Precision Plumbing Products, Inc.
j. Victaulic Company.
k. Watts Regulator Co.
l. Zurn Industries, LLC.

B. Description: Combination of copper alloy and ferrous; threaded, solder, plain, and weld-neck end types and matching piping system materials.

C. Insulating Material: Suitable for system fluid, pressure, and temperature.

D. **End Connections:** Threaded, or flanged.

E. **End Connections:** Grooved.

F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and **300-psig** minimum working pressure at **225 deg F**.

G. Dielectric Nipples or Waterways: Electroplated steel with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and **300-psig** minimum working pressure at **225 deg F**.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Hot-water heating piping, aboveground, NPS 2 and smaller shall be **[any of]** the following:

1. **Type L** drawn-temper copper tubing, wrought-copper fittings, and **soldered** joints.
2. **Schedule 40**, Grade B, Type 96 steel pipe; **Class 125, cast-iron** fittings; cast-iron flanges and flange fittings; and threaded joints.

B. Hot-water heating piping, aboveground, NPS 2-1/2 and larger, shall be **[any of]** the following:

1. **Type L**, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
2. **Schedule 40** steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
3. **Schedule 40** steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.

C. Chilled-water piping, aboveground, NPS 2 and smaller, shall be **[any of]** the following:

1. **Type L**, drawn-temper copper tubing, wrought-copper fittings, and **soldered** joints.
2. **Schedule 40**, Grade B, Type 96 steel pipe; **Class 125, cast-iron** fittings; cast-iron flanges and flange fittings; and threaded joints.

D. Chilled-water piping, aboveground, NPS 2-1/2 and larger, shall be **[any of]** the following:

1. **Type L**, drawn-temper copper tubing, wrought-copper fittings, and **soldered** joints.
2. **Schedule 40** steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
3. **Schedule 40** steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.

E. Makeup-water piping installed aboveground shall be **[any of]** the following:

1. **Type L**, drawn-temper copper tubing, wrought-copper fittings, and **soldered** joints.

F. Condensate-drain piping shall be **any of** the following:

1. **Type M**, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

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

H. Air-Vent Piping:

1. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems according to piping manufacturer's written instructions.
2. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.

I. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed with metal-to-plastic transition fittings for plastic piping systems according to piping manufacturer's written instructions.

3.2 PIPING INSTALLATIONS

A. PRE-WORK / PRE-REQUISITES

1. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

2. The Contractor shall study the architectural, structural, mechanical, electrical and other drawings to eliminate conflict of piping with other structure lighting or other services.

B. CONDITION

1. All installed pipe lines shall be free from dents, scars, and burrs, with ends reamed smooth.

2. All piping shall be clean and free from acids and loose dirt when installed and shall be kept clean during the completion of the installation.

3. Install piping free of sags and bends.

4. All installed pipe lines shall remain straight against strains tending to cause distortion during system operation. The contractor shall make proper allowance for pipe line expansion and contraction so that no unsightly distortion, noise, damage or improper operation results therefrom.

C. SELECTION

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

2. No street type fittings shall be used.

3. No short nipples shall be used except at drain valves.

4. Plugs of rags, wools, cottons, waste, or similar materials may not be used for plugging.

D. ROUTING/ARRANGEMENT

1. Piping installations shall be neatly organized.

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

3. Install groups of pipes parallel to each other.

4. Install piping spaced to permit application of insulation.

5. Install piping parallel and spaced to permit the servicing of valves.

6. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls or axis of the building.

7. Diagonal runs are prohibited unless specifically indicated otherwise.

8. Install fittings for all changes in direction.

9. No piping shall be run above any electrical panels, electrical equipment or access clearances for electrical for electrical panels or equipment. No piping shall be allowed to run through any electrical rooms.

10. Piping shall be arranged, placed and installed to facilitate equipment maintenance and shall be so arranged to not interfere with the installation of the air-conditioning equipment, ducts, or the removal of other equipment or devices. All specialties shall be so placed to permit easy operation and access.

11. All piping shall be so installed to insure noiseless circulation.

12. Install fittings for all branch connections.

13. Unless otherwise indicated, install branch connections to mains using [mechanically formed] tee fittings or forged steel branch fittings in main pipe, with the branch connected to the bottom of the main pipe.

14. For up-feed risers, connect the branch to the top of the main pipe.

15. Forged branch fittings shall be installed per the manufacturer’s recommendations.

E. ACCESS / ARRANGEMENT

1. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal. All piping shall be so arranged to not block access to manholes, access openings, etc.

2. Install piping at indicated slopes. If not indicated, install piping at a uniform grade of 0.2 percent where possible, upward in direction of flow. Traps are to be avoided where-ever possible.

3. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

4. When insulated pipes are supported by a roller hanger they shall be protected from damage by suitable pipe covering protection saddles. Saddles shall support pipe on roller and shall be packed with insulation.

5. Install valves according to Section 230523 "General-Duty Valves for HVAC Piping."

6. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, at each coil on all sides of automatic valves where valves do not have union connections, elsewhere as indicated, and wherever necessary to prevent undue difficulty in making repairs or replacement. Unions are not required at flanged connections.

7. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated. Install flanges on valves, apparatus, and equipment having 2 ½ inch NPS and larger connections. Flanges or unions as applicable for the type of piping specified, shall be provided in the piping at connections to all items of equipment.

8. Install shutoff valve immediately upstream of each dielectric fitting. Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

9. Comply with requirements in Section 230516 "Expansion Fittings and Loops for HVAC Piping" for installation of expansion loops, expansion joints, anchors, and pipe alignment guides. Anchor piping for proper direction of expansion and contraction.

10. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

11. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

12. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

13. Install strainers on supply side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS ¾) nipple and ball valve in blow-down connection of strainers NPS 2) and larger. Match size of strainer blow-off connection for strainers smaller than NPS 2).

14. Install flexible connectors at inlet and discharge connections to pumps (except inline pumps) and other vibration-producing equipment.

15. Polypropylene pipe in or passing through plenums must be fire wrapped or installed in a metal conduit.

F. DRAINAGE

1. Drain valves shall be installed at all low points in all piping systems to allow for complete drainage of piping systems.

2. 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.

3. All piping systems shall be installed so that they can be easily drained by means of drainage of low points of all piping without disconnecting pipe.

4. If not specifically indicated on the drawings, the frequency of draining shall determine whether drain caps, plugs, cocks, or valves are to be used.

G. IDENTIFICATION

1. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for identifying piping.

3.3 DIELECTRIC FITTING INSTALLATION

A. Make connections according to the following, unless otherwise indicated:

1. **Install dielectric nipples or waterways** in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.

2. Install **waterways**, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3. Install Dielectric Fittings into Hydronic Piping Systems: Install dielectric nipples, waterways or couplings to connect piping materials of dissimilar metals.

4. **End Connections**: **Threaded, or flanged.**
5. **End Connections**: **Grooved.**

3.4 HANGERS AND SUPPORTS

A. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hanger, support, and anchor devices. Comply with the following requirements for maximum spacing of supports.

B. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraints.

C. Steel roof deck shall not be used to support loads from piping, ductwork or equipment, unless noted otherwise. Hanger loads less than 50 lbs. may be hung from the steel roof deck in cases when hanging from the steel roof deck cannot be avoided; the attachment method must distribute the load across the deck as approved by the Structural Engineer.

D. 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.

E. 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, 3/8 inch.
2. NPS 1: Maximum span, 7 feet; minimum rod size, 3/8 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, 1/2 inch.
6. NPS 3 and Larger: Maximum span, 12 feet; minimum rod size, 1/2 inch.

F. 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 1-1/4: Maximum span, 7 feet; minimum rod size, 3/8 inch.
4. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
5. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
6. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
7. NPS 3 and Larger: Maximum span, 10 feet; minimum rod size, 3/8 inch.

G. PVC and CPVC 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.

H. PP Piping Hanger Spacing: Install vinyl-coated hangers with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1 and Smaller: 36 inches with 3/8-inch rod.
2. NPS 1-1/4 to NPS 2: 48 inches with 3/8-inch rod.
3. NPS 2-1/2 to NPS 3-1/2: 48 inches with 1/2-inch rod.
4. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
5. NPS 6: 48 inches with 3/4-inch rod.
6. NPS 8: 48 inches with 7/8-inch rod.
7. Space all sizes of fiberglass composite reinforced PP pipe according to the manufacturer's written instructions.

I. Install supports for vertical PP piping every 60 inches for NPS 1 and smaller, and every 72 inches for NPS 1-1/4 and larger.

J. Fiberglass Piping Hanger Spacing: Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.

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

L. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.5 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. 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.

D. 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.

E. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

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

F. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.

G. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

H. Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts.
1. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness. Use grooved-end fittings and rigid, grooved-end-pipe couplings.
2. Installed in accordance with the manufacturer’s written recommendations.
3. Ends shall be clean and free from indentations, projections or roll marks.
4. The gasket shall be molded and produced by the coupling manufacturer of an elastomer suitable for the intended service.
5. Unions and flanges for servicing and disconnect are not required in installations using grooved joint couplings.
6. Training: The coupling manufacturer’s factory-direct trained representative shall provide on-site training for the contractor’s field personnel in the use of grooving tools and installation of product. The representative shall periodically visit the job site to ensure best practices in grooved product installation are being followed. The distributor’s representative will not be acceptable.

3.6 TERMINAL EQUIPMENT CONNECTIONS

A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install control valves in accessible locations close to connected equipment.

3.7 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.

5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Isolate expansion tanks and determine that hydronic system is full of water.
4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times the "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

C. Perform the following before operating the system:

1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

END OF SECTION 232113

SECTION 232113.13 - UNDERGROUND 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. Section Includes:

1. Copper tube and fittings.
2. Steel pipes and fittings.
3. Ductile-iron pipe and fittings.
4. Plastic pipe and fittings.
5. Fiberglass pipe and fittings.
6. Transition fittings.
7. Conduit piping system.
8. Cased piping system.
9. Loose-fill insulation.

1.3 PERFORMANCE REQUIREMENTS

A. Provide components and installation capable of producing hydronic piping systems with the following minimum working-pressure ratings:
   1. Chilled-Water Piping: 150 psig (1035 kPa) at 140 deg F (60 deg C).

1.4 ACTION SUBMITTALS

A. Product Data: For the following:

1. Conduit piping.
2. Cased piping.
3. Loose-fill insulation.

B. LEED Submittals:

1. Product Data for Credit EQ 4.1: For adhesives, documentation including printed statement of VOC content and chemical components.

C. Shop Drawings: For underground hydronic piping. Signed and sealed by a professional engineer.

1. Calculate requirements for expansion compensation for underground piping.
2. Show expansion compensators, offsets, and loops with appropriate materials to allow piping movement in the required locations. Show anchors and guides that restrain piping movement with calculated loads, and show concrete thrust block dimensions.
3. Show pipe sizes, locations, and elevations. Show piping in trench, conduit, and cased pipe with details showing clearances between piping, and show insulation thickness.

1.5 INFORMATIONAL SUBMITTALS

A. Profile Drawings: Show system piping in elevation. Draw profiles at horizontal scale of not less than 1 inch equals 50 feet (1:500) and at vertical scale of not less than 1 inch equals 5 feet (1:50). Indicate manholes and piping. Show types, sizes, materials, and elevations of other utilities crossing hydronic piping.

B. Qualification Data: For qualified Installer.

C. Welding certificates.

D. Material Test Reports: For conduit and cased piping.

E. Source quality-control reports.

F. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX.

1. Comply with provisions in ASME B31.9, "Building Services Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

B. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type L (ASTM B 88M, Type B). [ASTM B 88, Type K (ASTM B 88M, Type A.

B. Wrought-Copper Fittings: ASME B16.22.

C. Wrought-Copper Unions: ASME B16.22.

D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

E. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

2.2 STEEL PIPES AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black [galvanized] with plain ends; type, grade, and wall thickness as indicated in "Piping Application" Article.

B. Cast-Iron, Threaded Fittings: ASME B16.4; Class 125. [and] [Class 250].

C. Malleable-Iron, Threaded Fittings: ASME B16.3, Class 150. [and] [Class 300].

D. Malleable-Iron Unions: ASME B16.39; Class 150. [Class 250] [and] [Class 300].

E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Class 125 [and] [Class 250]; raised ground face, and bolt holes spot faced.

F. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

G. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

1. Material Group: 1.1.
2. End Connections: Butt welding.
3. Facings: Raised face.

H. Steel Welding Fittings: ASME B16.9 and ASTM A 234/A 234M, seamless or welded.

1. 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.

I. Forged Steel “Olet” Type Fittings, Welding, Socket-Welding and Threaded: ASME B16.11 and ASTM A105.

1. 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.

J. Grooved-End-Pipe Couplings for Galvanized-Steel Piping: AWWA C606 for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gaskets suitable for hot and cold water, and bolts and nuts.

K. Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.

L. 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 (3.2-mm) maximum thickness unless thickness or specific material is indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and -bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

M. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

2.3 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151/A21.51, with mechanical-joint bell and plain spigot end.

1. Standard-Pattern, Mechanical-Joint Fittings: AWWA C110/A21.10, ductile or gray iron.
2. Compact-Pattern, Mechanical-Joint Fittings: AWWA C153/A21.53, ductile iron.

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

2.4 PLASTIC PIPE AND FITTINGS

A. CPVC Plastic:

1. Pipe: ASTM F 441/F 441M, Schedules 40 and 80, plain ends as indicated in "Piping Application" Article.
2. Pipe Fittings: Socket-type pipe fittings, ASTM F 438 for Schedule 40 pipe; ASTM F 439 for Schedule 80 pipe.
3. Solvent Cements: ASTM F 493.

a. Use CPVC solvent cement that has a VOC content of 490 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
b. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. PVC Plastic:

1. Pipe: ASTM D 1785, Schedules 40 and 80, plain ends as indicated in "Piping Application" Article.
2. Pipe Fittings: Socket-type pipe fittings, ASTM D 2466 for Schedule 40 pipe; ASTM D 2467 for Schedule 80 pipe.

3. Solvent Cements: ASTM D 2564. Include primer according to ASTM F 656.

   a. Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   b. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. PP (Polypropylene) Pipe: ASTM F 2389, SDR 7.4 and fiberglass composite reinforced SDR 11.
   1. PP Fusion-weld Socket Fittings: ASTM F 2389.

D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

2.5 FIBERGLASS PIPE AND FITTINGS

A. RTRP: ASTM D 2996, filament-wound pipe with tapered bell and spigot ends for adhesive joints.

B. RTRF: Compression or spray up/contact molded of same material, pressure class, and joining method as pipe.

C. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

   1. Use fiberglass 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. Flanges: ASTM D 4024. Full-face gaskets suitable for the service, minimum 1/8-inch- (3.2-mm-) thick, 60-70 durometer. ASTM A 307, Grade B, hex-head bolts with washers.

2.6 TRANSITION FITTINGS

A. Plastic-to-Metal Transition Fittings One-piece fitting with one threaded brass or copper insert and one Schedule 80 solvent-cemented- or fusion-joint end.

2.7 CASED PIPING SYSTEM

A. Description: Factory-fabricated piping with carrier pipe, insulation, and casing.

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

      a. Insul-Tek Piping Systems, Inc.
      b. Perma-Pipe, Inc.
      c. Rovanco Piping Systems, Inc.
      d. Thermacor Process, L.P.

e. Thermal Pipe Systems.
f. Urecon Ltd.

B. Carrier Pipe: Schedule 40, steel pipe and fittings. [Copper tube and fittings] [Standard-weight, steel pipe and fittings] [Schedule 80, steel pipe and fittings] [Ductile-iron pipe and fittings] [Plastic pipe and fittings] [Fiberglass pipe and fittings].

C. Carrier Pipe Insulation:

1. Polyurethane Foam Pipe Insulation: Rigid, cellular, high-pressure injected between carrier pipe and jacket.

a. Comply with ASTM C 591; thermal conductivity (k-value) shall not exceed 0.14 Btu x in./h x sq. ft. x deg F (0.020 W/m x K) at 75 deg F (24 deg C) after 180 days of aging.

D. Casing: HDPE. [Filament-wound, fiberglass-reinforced polyester resin] [PVC] [0.034-inch- (0.85-mm-) thick, spiral-wound, lock-seam galvanized steel] [0.032-inch- (0.80-mm-) thick, spiral-wound, lock-seam aluminum] [0.025-inch- (0.65-mm-) thick, spiral-wound, lock-seam stainless steel].

E. Casing accessories include the following:

1. Joint Kit: Half-shell, pourable or split insulation, casing sleeve, and shrink-wrap sleeve.
2. Expansion Blanket: Elastomeric foam, formed to fit over piping.
3. End Seals: Shrink wrap the casing material to seal watertight around casing and carrier pipe.

F. Manholes: Black steel with lifting eyes.

1. Finish: Spray-applied urethane, minimum 30 mils (0.75 mm) thick.
2. Access: 30-inch- (750-mm-) diameter waterproof cover with gasket, ladder, and two 6-inch (150-mm) vents, one high and one low, extending above grade with rain caps.
3. Conduit Stub-Outs and Seals: Welded steel with drain and vent openings.
4. Sump: 12 inches (300 mm) in diameter,12 inches (300 mm) deep.
5. Floatation Anchor: Oversized bottom keyed into concrete base.

G. Source Quality Control: Factory test the carrier pipe to 150 percent of the operating pressure of system. Furnish test certificates.

2.8 LOOSE-FILL INSULATION

A. Granular, Loose-Fill Insulation: Inorganic, nontoxic, nonflammable, sodium potassium aluminum silicate with calcium carbonate filler. Include chemical treatment that renders insulation hydrophobic.

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

   a. Gilsulate International, Inc.

2. Thermal Conductivity (k-Value): 0.60 at 175 deg F (0.087 at 79 deg C) and 0.65 at 300 deg F (0.094 at 149 deg C).
3. Application Temperature Range: 35 to 800 deg F (2 to 426 deg C).
4. Dry Density: 40 to 42 lb/cu. ft. (640 to 672 kg/cu. m).
5. Strength: 12,000 lb/sq. ft. (58 600 kg/sq. m).

B. Powder, Loose-Fill Insulation: Inert, nontoxic, nonflammable, calcium carbonate particles. Include chemical treatment that renders insulation hydrophobic.

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

   a. DriTherm International Inc.

2. Thermal Conductivity (k-Value): ASTM C 177, 0.58 at 100 deg F (0.084 at 37 deg C) and 0.68 at 300 deg F (0.098 at 149 deg C).
3. (Minus 169 to plus 250 deg C).
4. Dry Density: Approximately 60 lb/cu. ft. (960 kg/cu. m).
5. Strength: 12,000 lb/sq. ft. (58 600 kg/sq. m).

PART 3 - EXECUTION

3.1 EARTHWORK

A. See Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATION

A. Hot-Water Heating Piping:

1. NPS 2 (DN 50) and smaller shall be any of the following:

   a. Type L (Type B), [Type M (Type C)] [Type K (Type A)] drawn-temper copper tubing, wrought-copper fittings, and brazed [soldered] joints.
   b. Schedule 40 [Schedule 30] [Schedule 20] steel pipe; Class 125, cast-iron [Class 150, malleable-iron] [Class 250, cast-iron] [Class 300, malleable-iron] fittings; cast-iron flanges and flange fittings; and threaded joints.
   c. SD 7.4 PP pipe with PP fusion socket fittings and fusion joints or butt-fusion joints.

d. SD 11 fiberglass composite reinforced PP pipe with PP fusion socket fittings and fusion joints or butt-fusion joints.
e. [Schedule 40] [Schedule 80] CPVC plastic pipe and fittings and solvent-welded joints.
f. Loose-Fill Insulation: Granular or Powder.

2. NPS 2-1/2 (DN 65) and larger shall be any of the following:

a. Type L (Type B), [Type M (Type C)] [Type K (Type A)] drawn-temper copper tubing, wrought-copper fittings, and brazed [soldered] joints.
b. Schedule 40 [Schedule 30] [Schedule 20] steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
c. SD 7.4 PP pipe with PP fusion socket fittings and fusion joints or butt-fusion joints.
d. SD 11 fiberglass composite reinforced PP pipe with PP fusion socket fittings and fusion joints or butt-fusion joints.
e. Loose-Fill Insulation: Granular or Powder.

3. Cased piping with polyurethane carrier-pipe insulation.

a. Piping Insulation Thickness: 2 inches (50 mm). [1 inch (25 mm)] <Insert dimension>.

B. Chilled-Water Piping:

1. NPS 2 (DN 50) and smaller shall be any of the following:

a. Type L (Type B), [Type M (Type C)] [Type K (Type A)] drawn-temper copper tubing, wrought-copper fittings, and brazed [soldered] joints.
b. Schedule 40 [Schedule 30] [Schedule 20] steel pipe; Class 125, cast-iron [Class 150, malleable-iron] [Class 250, cast-iron] [Class 300, malleable-iron] fittings; cast-iron flanges and flange fittings; and threaded joints.
c. SD 7.4 PP pipe with PP fusion socket fittings and fusion joints or butt-fusion joints.
d. SD 11 fiberglass composite reinforced PP pipe with PP fusion socket fittings and fusion joints or butt-fusion joints.
e. [Schedule 40] [Schedule 80] CPVC plastic pipe and fittings and solvent-welded joints.
f. Loose-Fill Insulation: Granular or Powder.

2. NPS 2-1/2 (DN 65) and larger shall be any of the following:

a. Type L (Type B), [Type M (Type C)] [Type K (Type A)] drawn-temper copper tubing, wrought-copper fittings, and brazed [soldered] joints.
b. Schedule 40 [Schedule 30] [Schedule 20] steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.

c. Mechanical-joint, ductile-iron pipe; standard- or compact- pattern mechanical-joint fittings; and mechanical joints.
d. SD 7.4 PP pipe with PP fusion socket fittings and fusion joints or butt-fusion joints.
e. SD 11 fiberglass composite reinforced PP pipe with PP fusion socket fittings and fusion joints or butt-fusion joints.
f. [Schedule 40] [Schedule 80] CPVC plastic pipe and fittings and solvent-welded joints.
g. RTRP and RTRF with adhesive or flanged joints.
h. Loose-Fill Insulation: Granular or Powder.

3. Cased piping with polyurethane carrier-pipe insulation.

a. Piping Insulation Thickness: 2 inches (50 mm). [1 inch (25 mm)] <Insert dimension>.

C. Condenser-Water Piping:

1. NPS 2 (DN 50) and smaller shall be any of the following:

a. Type L (Type B), [Type M (Type C)] [Type K (Type A)] drawn-temper copper tubing, wrought-copper fittings, and brazed [soldered] joints.
b. Schedule 40 [Schedule 30] [Schedule 20] steel pipe; Class 125, cast-iron [Class 150, malleable-iron] [Class 250, cast-iron] [Class 300, malleable-iron] fittings; cast-iron flanges and flange fittings; and threaded joints.
c. SD 7.4 PP pipe with PP fusion socket fittings and fusion joints or butt-fusion joints.
d. SD 11 fiberglass composite reinforced PP pipe with PP fusion socket fittings and fusion joints or butt-fusion joints.
e. [Schedule 40] [Schedule 80] CPVC plastic pipe and fittings and solvent-welded joints.
f. Loose-Fill Insulation: Granular or Powder.

2. NPS 2-1/2 (DN 65) and larger shall be any of the following:

a. Type L (Type B), [Type M (Type C)] [Type K (Type A)] drawn-temper copper tubing, wrought-copper fittings, and brazed [soldered] joints.
b. Schedule 40 [Schedule 30] [Schedule 20] steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
c. Mechanical-joint, ductile-iron pipe; standard- or compact- pattern mechanical-joint fittings; and mechanical joints.
d. SD 7.4 PP pipe with PP fusion socket fittings and fusion joints or butt-fusion joints.
e. SD 11 fiberglass composite reinforced PP pipe with PP fusion socket fittings and fusion joints or butt-fusion joints.
f. [Schedule 40] [Schedule 80] CPVC plastic pipe and fittings and solvent-welded joints.

g. RTRP and RTRF with adhesive or flanged joints.
h. Loose-Fill Insulation: Granular or Powder.

3. Cased piping with polyurethane carrier-pipe insulation.

a. Piping Insulation Thickness: 2 inches (50 mm). [1 inch (25 mm)] <Insert dimension>.

3.3 PIPING INSTALLATION

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. Remove standing water in the bottom of trench.

C. Do not backfill piping trench until field quality-control testing has been completed and results approved.

D. Install piping at uniform grade of 0.2 percent. Install drains, consisting of a tee fitting, NPS 3/4 (DN 20) ball valve, and short NPS 3/4 (DN 20) threaded nipple with cap, at low points and elsewhere as required for system drainage. Install manual air vents at high points.

E. In conduits, install drain valves at low points and manual air vents at high points.

F. Install components with pressure rating equal to or greater than system operating pressure.

G. Install piping free of sags and bends.

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

I. See Section 230517 "Sleeves and Sleeve Seals for HVAC Piping" for sleeves and mechanical sleeve seals through exterior building walls.

J. Secure anchors with concrete thrust blocks. Concrete is specified in Section 033000 "Cast-in-Place Concrete."

K. See Section 264200 "Cathodic Protection" for cathodic devices and connections to piping and conduit systems.

3.4 LOOSE-FILL INSULATION INSTALLATION

A. Do not disturb the bottom of trench; otherwise, compact and stabilize it to ensure proper support.

B. Remove standing water in the bottom of trench.

C. Bed the pipe on a minimum 6-inch (150-mm) layer of granular fill material with a minimum 6-inch (150-mm) clearance between the pipes.

D. Form insulation trench by excavation or by installing drywall side forms to establish required height and width of the insulation.

E. Support piping with proper pitch, separation, and clearance to backfill or side forms using temporary supporting devices that can be removed after back filling with insulation.

F. Place insulation and backfill after field quality-control testing has been completed and results approved.

G. Apply bitumastic coating to carbon-steel anchors and guides. Pour concrete thrust blocks and anchors. See Section 033000 "Cast-in-Place Concrete" for concrete and reinforcement.

H. Wrap piping at expansion loops and offsets with mineral-wool insulation of thickness appropriate for calculated expansion amount.

I. Pour loose-fill insulation to required dimension agitating insulation to eliminate voids around piping.

J. Remove temporary hangers and supports.

K. Cover loose-fill insulation with polyethylene sheet a minimum of 4 mils (0.10 mm) thick, and empty loose-fill insulation bags on top.

L. Manually backfill 6 inches (150 mm) of clean backfill. If mechanical compaction is required, manually backfill to 12 inches (300 mm) before using mechanical-compaction equipment.

3.5 JOINT CONSTRUCTION

A. See Section 330500 "Common Work Results for Utilities" for basic piping joint construction.

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," Ch. 35, "Pipe and Tubing," using copper-phosphorus brazing filler metal complying with AWS A5.8/A5.8M.

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 D10.12M/D10.12, using qualified processes and welding operators according to "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. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
3. PVC Pressure Piping: Join ASTM D 1785 schedule number, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule number PVC pipe and socket fittings according to ASTM D 2855.

J. PP Fusion Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM D2657 and the manufacturer’s recommendations.

K. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

L. Conduit and Cased Piping Joints: Assemble sections according to the manufacturer’s instructions. Finish joints with pourable or split insulation and exterior jacket sleeve, and apply shrink-wrap seals.

3.6 IDENTIFICATION

A. Install continuous plastic underground warning tapes during back filling of trenches for underground hydronic piping. Locate tapes 6 to 8 inches (150 to 200 mm) below finished grade, directly over piping. See Section 312000 "Earth Moving" for warning-tape materials and devices and their installation.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: [Owner will engage] Engage a qualified testing agency to perform tests and inspections.

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 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.

D. Tests and Inspections:

1. Prepare hydronic piping for testing according to ASME B31.9 and as follows:

a. Leave joints, including welds, uninsulated and exposed for examination during test.
b. Fill system with water. Where there is risk of freezing, air or a safe, compatible liquid may be used.
c. Use vents installed at high points to release trapped air while filling system.

2. Test hydronic piping as follows:

a. Subject hydronic piping to hydrostatic test pressure that is not less than 1.5 times the design pressure.
b. After hydrostatic test pressure has been applied for 10 minutes, examine joints for leakage. Remake leaking joints using new materials and repeat hydrostatic test until no leaks exist.

E. Prepare test and inspection reports.

END OF SECTION 232113.13

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 special-duty valves and specialties for the following:
   1. Hot-water heating piping.
   2. Chilled-water piping.
   3. Makeup-water piping.
   4. Condensate-drain piping.
   5. Air-vent piping.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of the following:
   1. Valves: Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
   2. Air-control devices.
   3. Hydronic specialties.

1.4 CLOSEOUT SUBMITTALS

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

1.5 QUALITY ASSURANCE

A. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
   1. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - PRODUCTS

2.1 VALVES

A. **Globe, Check, Ball, and Butterfly Valves**: Comply with requirements specified in Section 230523 "General-Duty Valves for HVAC Piping. Gate valves are not allowed on this project.

B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Section 230900 "Instrumentation and Control for HVAC.

C. Refer to Part 3 “Valve Applications” Article for applications of each valve.

D. Bronze, Calibrated-Orifice or Venturi, Balancing Valves, NPS 2 and smaller:

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

a. Armstrong Pumps, Inc.
b. Bell & Gossett Domestic Pump.
c. Flow Design Inc.
d. Gerand Engineering Co.
e. Griswold Controls.
f. Taco.
g. Tour & Andersson; available through Victaulic Company.
h. Tyco-Grinnell

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

E. Cast-Iron or Steel, Calibrated-Orifice or Venturi, Balancing Valves, NPS 2 ½ and larger:

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

a. Amtrol, Inc.
b. Armstrong Pumps, Inc.
c. Bell & Gossett Domestic Pump.

d. Flow Design Inc.
e. Gerand Engineering Co.
f. Grinnell.
g. Griswold Controls.
h. Taco.
i. Tour & Andersson; available through Victaulic Company.
j. Spence Engineering Company Inc.
k. Watts Regulator Co.

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

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

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

a. Amtrol, Inc.
b. Armstrong Pumps, Inc.
c. Bell & Gossett Domestic Pump.
d. Conbraco Industries, Inc.
e. Spence Engineering Company, Inc.
f. Watts Regulator Co.

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: **Brass**, 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.

G. Diaphragm-Operated Safety Valves: ASME labeled.

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

a. Amtrol, Inc.
b. Armstrong Pumps, Inc.
c. Bell & Gossett Domestic Pump.
d. Conbraco Industries, Inc.
e. Kunkle.
f. Spence Engineering Company, 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: **Brass,** 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.

H. Automatic Flow-Control Valves:

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

a. Armstrong Pumps, Inc.
b. Bell & Gossett Domestic Pump.
c. Flow Design Inc.
d. Griswold Controls.
e. Taco

2. Body: Brass or ferrous metal.
3. Piston and Spring Assembly: Tamper proof, self-cleaning, and removable, for inspections and replacement.
   a. **Corrosion resistant.**
4. Combination Assemblies: Include bronze or brass-alloy ball valve.
5. Identification Tag: Attached by chain and marked with zone identification, valve number, and flow rate.
6. Size: Same as pipe in which installed.
7. Performance: Maintain constant flow, plus or minus 5 percent over system pressure fluctuations:
   a. **Minimum CWP Rating**: **175 psig**.
8. **Maximum Operating Temperature: 200 deg F**.
9. Fitted with pressure and temperature test valves.
10. Equipped with a readout kit including flow meter, probes, hoses, flow charts, and carrying case.

2.2 AIR-CONTROL DEVICES

A. Manual Air Vents:

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

   a. Amtrol, Inc.
   b. Armstrong Pumps, Inc.
   c. Bell & Gossett Domestic Pump.
   d. Taco, Inc.

2. Body: Bronze.
3. Internal Parts: Nonferrous.
4. Operator: Screwdriver or thumbscrew.
5. Manually operated with ball valve in the down position.
6. Inlet Connection: **NPS 1/2**.
7. Discharge Connection: **NPS 1/8**.
8. CWP Rating: **150 psig**.
9. Maximum Operating Temperature: **225 deg F**.

B. Automatic Air Vents:

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

   a. Amtrol, Inc.
   b. Bell & Gossett Domestic Pump.
   c. Hoffman Specialty ITT; Fluid Handling Div.
   d. Spirax-Sarco.
   e. Spirovent.
   f. Taco, Inc.
   g. Honeywell-Baukman.

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

C. **Bladder -**Type Expansion Tanks:

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

   a. Amtrol, Inc.

b. Armstrong Pumps, Inc.
c. Bell & Gossett Domestic Pump.
d. Taco, Inc.

2. Tank: Welded steel, rated for **125-psig** working pressure and **240 deg F** maximum operating temperature. Factory test after taps are fabricated and supports installed and are labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

3. **Bladder** : Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.

4. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.
5. Access: Drain fitting and taps for pressure gage.
6. Support:
   a. Vertical tanks with steel legs or base.
   b. Horizontal tanks with steel saddles.

D. Tangential-Type Air Separators:

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

   a. Amtrol, Inc.
   b. Armstrong Pumps, Inc.
   c. Bell & Gossett Domestic Pump.
   d. Taco, Inc.

2. Tank: Welded steel; ASME constructed and labeled for **125-psig** minimum working pressure and **240 deg F** maximum operating temperature.
3. Air Collector Tube: Perforated stainless steel, constructed to direct released air into expansion tank.
4. Tangential Inlet and Outlet Connections: Threaded for **NPS 2** and smaller; flanged connections for **NPS 2-1/2** and larger.
5. Blowdown Connection: Threaded.
6. Size: Match system flow capacity.

2.3 HYDRONIC PIPING SPECIALTIES

A. Y-Pattern Strainers:

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

   a. Armstrong Machine Works.
   b. Hoffman Specialty ITT; Fluid Handling Div.
   c. Metraflex Co.
   d. Spirax Sarco.

e. Trane Co.
f. Tyco-Grinnell.
g. Tour & Andersson; available through Victaulic Company.
h. Watts Regulator Co.

2. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
3. End Connections: Threaded ends for **NPS 2** and smaller; flanged ends for **NPS 2-1/2** and larger.
4. Strainer Screen: Stainless-steel, or perforated stainless-steel basket:
   a. **20**-mesh strainer.
5. CWP Rating: **125 psig**.

B. Basket Strainers:

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

   a. Crane Co.
   b. Metraflex Co.
   c. Spirax Sarco.
   d. Tyco-Grinnell.
   e. Tour & Andersson; available through Victaulic Company.

2. Body: ASTM A 126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
3. End Connections: Threaded ends for **NPS 2** and smaller; flanged ends for **NPS 2-1/2** and larger.
4. Strainer Screen: Perforated stainless-steel basket with 50 percent free area:
   a. 40-mesh startup strainer.
5. CWP Rating: **125 psig**.

C. Stainless-Steel Braided-Corrugated, Flexible Connectors:

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

   a. Amber-Booth.
   b. Mason Industries.
   c. Metraflex Co.
   d. Flex-Weld.
   e. Fugate.
   f. Twin City Hose.

2. Body: 321 Stainless-steel close pitch corrugated hose with woven, flexible, 304 Stainless-steel, protective jacket.
3. End Connections: Flanged, ANSI Class 150 carbon steel

4. Performance: Permanent Offset; 3/8 inch, Intermittent Offset; 1/8 inch.
5. Safe Working Pressure: **175 psig**. (For 8 inch diameter)
6. Maximum Operating Temperature: **200 deg F**. (For 8 inch diameter)

D. Diverting Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Amtrol, Inc.
   b. Armstrong Pumps, Inc.
   c. Bell & Gossett Domestic Pump.
   d. Taco, Inc.

2. Body: Cast Iron or Wrought Copper
3. Ends: Threaded or Soldered
4. Flow Direction: Indicated on fitting.
5. CWP Rating: **125 psig**.
6. Maximum Operating Temperature: **250 deg F**.

PART 3 - EXECUTION

3.1 VALVE APPLICATIONS

A. Install shutoff-duty valves at each branch connection to supply mains and at supply connection to each piece of equipment.

B. **Install calibrated-orifice,** balancing valves at each branch connection to return main.

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

D. Install check valves at each pump discharge and elsewhere as required to control flow direction.

E. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

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

3.2 HYDRONIC SPECIALTIES INSTALLATION

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

B. Automatic air vents may cause damage to ceilings and other finished surfaces. Air vents aid in system filling. Air removal after initial startup is accomplished by air separator or boiler diptube. Manual air vents may be a better solution.

C. Install automatic air vents at high points of system piping in mechanical equipment rooms only. Install manual vents at heat-transfer coils and elsewhere as required for air venting.

D. Install piping from boiler air outlet, air separator, or air purger to expansion tank with a 2 percent upward slope toward tank.

E. Install in-line air separators in pump suction. Install drain valve on air separators **NPS 2** and larger.

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

G. Install expansion tanks above the air separator. Install tank fitting in tank bottom and charge tank. Use manual vent for initial fill to establish proper water level in tank.
   1. Install tank fittings that are shipped loose.
   2. Support tank from floor or structure above with sufficient strength to carry weight of tank, piping connections, fittings, plus tank full of water. Do not overload building components and structural members.

H. Install expansion tanks on the floor. Vent and purge air from hydronic system, and ensure that tank is properly charged with air to suit system Project requirements.

END OF SECTION 232116

SECTION 232123 - HYDRONIC PUMPS

PART 1 - GENERAL

1.1 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. Separately coupled, base-mounted, end-suction centrifugal pumps.

1.3 DEFINITIONS

A. Buna-N: Nitrile rubber.

B. EPT: Ethylene propylene terpolymer.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of pump. Include certified performance curves and rated capacities, shipping weights, installed weights, 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: For each pump.

   1. Show pump layout and connections.
   2. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
   3. Include diagrams for power, signal, and control wiring.
      a. Detail all wiring systems and differentiate clearly between manufacturer-installed and field-installed wiring.

1.5 CLOSEOUT SUBMITTALS

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

1.6 QUALITY ASSURANCE

A. UL Compliance: Fabricate and label pumps to comply with UL 778, "Motor-Operated Water Pumps," for construction requirements.

B. Product Options: Drawings indicate size, profiles, connections, and dimensional requirements of pumps and are based on the specific types and models indicated. Other manufacturers' pumps with equal performance characteristics may be considered. Refer to Division 1 Section "Substitutions."

C. Regulatory Requirements: Fabricate and test steam condensate pumps to comply with HI 1.1-1.5, "Centrifugal Pumps for Nomenclature, Definitions, Application and Operation," and HI 1.6, "Centrifugal Pump Tests."

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.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.

B. Store pumps in dry location.

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

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

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

1.8 COORDINATION

A. Coordinate size and location of concrete bases.

PART 2 - PRODUCTS

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

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Aurora Pump; Division of Pentair Pump Group.
   2. Flofab
   3. ITT Corporation; Bell & Gossett.
   4. PACO Pumps; Grundfos CBG.

5. Patterson Pump Co.; a subsidiary of the Gorman-Rupp Co.
6. TACO Incorporated.

B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, bronze fitted, 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. Rated for 175-psig minimum working pressure and a continuous water temperature of 225 deg F.

C. Pump Construction:

1. Casing: Radially split, cast iron, bronze fitted, with threaded gage tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and threaded companion-flange or flanged connections.
   a. Provide integral mount on volute to support the casing, and provide attached piping to allow removal and replacement of impeller without disconnecting piping or requiring the realignment of pump and motor shaft.
2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For pumps without frequency-drive control, trim impeller to match specified performance.
3. Pump Shaft: Steel, with copper-alloy shaft sleeve.
4. Seal: Mechanical seal consisting of 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: Grease-lubricated ball bearings in cast-iron housing with grease fittings.

D. Shaft Coupling: Molded-rubber insert and interlocking spider capable of absorbing vibration.
1. Couplings shall be drop-out type to allow disassembly and removal without removing pump shaft or motor.

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

F. Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A 36/A 36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor.

G. Motor: Single speed, secured to mounting frame, with adjustable alignment.

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

   a. Enclosure: Open, dripproof.

b. Enclosure Materials: Cast iron.

c. Motor Bearings: Grease-lubricated ball bearings.

d. Efficiency: Premium efficient.
e. Service Factor: 1.15

2.2 PUMP SPECIALTY FITTINGS

A. Suction Diffuser:

1. Angle pattern.
2. 175-psig pressure rating, cast-iron body and end cap, pump-inlet fitting.
3. Bronze startup and bronze or stainless-steel permanent strainers.
4. Bronze or stainless-steel straightening vanes.
5. Drain plug.
6. 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 the Work.

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

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

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

3.2 PUMP INSTALLATION

A. Install pumps according to HI 1.1-1.5, "Centrifugal Pumps for Nomenclature, Definitions, Application and Operation."

B. Comply with HI 1.4.

C. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.

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

E. Automatic Condensate Pump Units: Install units for collecting condensate and extend to open drain.

F. Equipment Mounting:

1. Install base-mounted pumps on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Division 03 “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."
3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

G. Equipment Mounting: Install in-line pumps with continuous-thread hanger rods and spring hangers elastomeric hangers of size required to support weight of in-line pumps.

1. Comply with requirements for seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
2. Comply with requirements for hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

3.3 ALIGNMENT

A. Engage a factory-authorized service representative to perform alignment service.

B. Comply with requirements in Hydronics Institute standards for alignment of pump and motor shaft. Add shims to the motor feet and bolt motor to base frame. Do not use grout between motor feet and base frame.

C. Comply with pump and coupling manufacturers' written instructions.

D. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

3.4 CONNECTIONS

A. Comply with requirements for piping specified in Division 23 Section "Steam and Condensate Heating Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to pump, allow space for service and maintenance.

C. Connect piping to pumps. Install valves that are same size as piping connected to pumps.

D. Install check, shutoff, and throttling on discharge side of pumps.

E. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.

F. Install suction diffuser and shutoff valve on suction side of vertical-inline and base-mounted pumps.

G. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.

H. Install pressure gages on pump suction and discharge or at integral pressure-gage tapping, or install single gage with multiple-input selector valve.

I. Install thermometers at pump suction and discharge.

J. Install check valve and gate or ball valve on each condensate pump unit discharge.

K. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
   1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

L. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
   1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

   1. Complete installation and startup checks according to manufacturer's written instructions.
   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 that electrical wiring installation complies with manufacturer's written instructions and the Contract Documents.
      b. Verify bearing lubrication.
      c. 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.
      d. 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. Open cooling water-supply valves in cooling water supply to bearings, where applicable.

7. Open cooling water-supply valves if stuffing boxes are water cooled.
8. Open sealing liquid-supply valves if pumps are so fitted.
9. Open warm-up valves of pumps handling hot liquids if pumps are not normally kept at operating temperature.
10. Open circulating line valves if pumps should not be operated against dead shutoff.
11. Start motor.
12. Open discharge valve slowly.
13. Observe leakage from stuffing boxes and adjust sealing liquid valve for proper flow to ensure lubrication of packing. Let packing "run in" before reducing leakage through stuffing boxes; then tighten glands.
14. Check general mechanical operation of pumps and motors.
15. Close circulating line valves once there is sufficient flow through pumps to prevent overheating.

B. When pumps are to be started against closed check valves with discharge shutoff valves open, steps are the same, except open discharge valves before starting motors.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps as specified below:

1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining pumps.
2. Review data in maintenance manuals. Refer to Division 1 Section "Contract Closeout."
3. Review data in maintenance manuals. Refer to Division 1 Section Contract Closeout.
4. Schedule training with Owner, through Architect, with at least seven days' advance notice.

END OF SECTION 232123

SECTION 232500 - HVAC WATER TREATMENT

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 HVAC water-treatment systems:

1. Bypass chemical-feed equipment and controls.
2. Biocide chemical-feed equipment and controls.
3. Ozone-generator biocide equipment and controls.
4. UV-irradiation unit, bio cide equipment, and controls.
5. Chemical treatment test equipment.
6. HVAC water-treatment chemicals.
7. Makeup water softeners.
8. RO equipment for HVAC makeup water.
9. Water filtration units for HVAC makeup water.

1.3 STANDARDS

A. ASHRAE 188 ‘P’.

1.4 DEFINITIONS

A. EEPROM: Electrically erasable, programmable read-only memory.

B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

C. RO: Reverse osmosis.

D. TDS: Total dissolved solids.

E. UV: Ultraviolet.

1.5 PERFORMANCE REQUIREMENTS

A. Water quality for HVAC systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of HVAC equipment without creating a hazard to operating personnel or the environment.

B. Base HVAC water treatment on quality of water available at Project site, HVAC system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.

C. Closed Hydronic Systems, including:

1. Hot-water heating.
2. Chilled water.

D. Closed Hydronic systems shall have the following water qualities:

1. pH: Maintain a value within the combined recommendations of the various equipment manufacturers.
2. "P" Alkalinity: Maintain a value within 100 to 500 ppm.
3. Nitrite: Maintain a value within 800 to 1000 ppm.
4. Microbiological Limits:

a. Total Aerobic Plate Count: Maintain a maximum value of 1000 organisms/ml.

E. Open Hydronic systems, including:

1. Condenser.

F. Open Hydronic systems shall have the following water qualities:

1. pH: Maintain a value within 7.8 to 9.1.
2. Soluble Copper: Maintain copper coupon corrosion rates below 0.1 mpy.
3. Conductivity: Maintain a minimum value of 2.5 times the conductivity of the make-up.
4. Microbiological Limits:

a. Total Aerobic Plate Count: Maintain a maximum value of 10,000 organisms/ml.
b. Legionella: Set up the system to control and maintain water chemistry consistent with ASHRAE 188 ‘P’.

G. Passivation for Galvanized Steel: For the first 60 days of operation.

1. pH: Maintain a value within 7 to 8.
2. Calcium Carbonate Hardness: Maintain a value within 100 to 300 ppm.
3. Calcium Carbonate Alkalinity: Maintain a value consistent with the recommendations of the Cooling Tower Manufacturer. (Units in ppm).

1.6 ACTION SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for the following products:

1. Bypass feeders.
2. Water meters.
3. Inhibitor injection timers.
4. pH controllers.
5. Conductivity controllers.
6. Biocide feeder timers.
7. Chemical solution tanks.
8. Injection pumps.
9. Ozone generators.
10. UV-irradiation units.
11. Chemical test equipment.
12. Chemical material safety data sheets.
13. Water softeners.
14. RO units.
15. Multimedia filters.
16. Self-cleaning strainers.
17. Bag- or cartridge-type filters.
18. Centrifugal separators.

B. Shop Drawings: Pretreatment and chemical treatment equipment showing tanks, maintenance space required, and piping connections to HVAC systems. Include plans, elevations, sections, details, and attachments to other work.

1. Wiring Diagrams: Power and control wiring.

1.7 INFORMATIONAL SUBMITTALS

A. Field quality-control test reports.

B. Manufacturer Seismic Qualification Certification:
1. Submit certification that the following equipment and components will withstand seismic forces defined in Section 230548 "Vibration and Seismic Controls for HVAC."
   a. Water softeners.
   b. RO equipment.
   c. Water filtration units.

2. Include the following:
   a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
      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."

2) 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."

3. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

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

C. Other Informational Submittals:

1. Water-Treatment Program: Written sequence of operation on an annual basis for the application equipment required to achieve water quality defined in the "Performance Requirements" Article above.
2. Water Analysis: Illustrate water quality available at Project site.
3. Passivation Confirmation Report: Verify passivation of galvanized-steel surfaces, and confirm this observation in a letter to Architect.

1.8 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data for the following equipment and controllers to include in emergency, operation, and maintenance manuals:
1. Sensors.
2. Injection pumps.

1.9 QUALITY ASSURANCE

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

B. Mechanical Equipment Contractor: Responsibilities to include installation of water-treatment equipment under the direction of the HVAC Water-Treatment Service Provider (above).

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.

1.10 MAINTENANCE SERVICE

A. Scope of Maintenance Service: Provide chemicals and service program to maintain water conditions required above to inhibit corrosion, scale formation, and biological growth for the following piping and equipment:

1. Cooling, chilled-water piping.

2. Heating, hot-water piping.
3. Condenser-water piping and equipment.

B. Services and chemicals shall be provided for a period of one year from date of Substantial Completion, and shall include the following:

1. Initial water analysis and HVAC water-treatment recommendations.
2. Startup assistance for Contractor to flush the systems, clean with detergents, and initially fill systems with required chemical treatment prior to operation.
3. Periodic field service and consultation.
4. Customer report charts and log sheets.
5. Laboratory technical analysis.
6. Analyses and reports of all chemical items concerning safety and compliance with government regulations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers/Providers: Subject to compliance with requirements, provide products by one of the following:
1. Power Engineering Co.
2. West Inc.

2.2 MANUAL CHEMICAL-FEED EQUIPMENT

A. Bypass Feeders: Steel, with corrosion-resistant exterior coating, minimum 3-1/2-inch fill opening in the top, and NPS 3/4 bottom inlet and top side outlet. Quarter turn or threaded fill cap with gasket seal and diaphragm to lock the top on the feeder when exposed to system pressure in the vessel.

1. Capacity:
   a. 5 gal.
2. Minimum Working Pressure: 125 psig.

2.3 AUTOMATIC CHEMICAL-FEED EQUIPMENT

1. AWWA C700, oscillating-piston, magnetic-drive, totalization meter.
2. Body: Bronze.
3. Minimum Working-Pressure Rating: 150 psig.
4. Maximum Pressure Loss at Design Flow: 3 psig.
5. Registration: Gallons or cubic feet.
6. End Connections: Threaded.

7. Controls: Flow-control switch with normally open contacts; rated for maximum 10 A, 250-V ac; and that will close at adjustable increments of total flow.

B. Water Meter:

1. AWWA C701, turbine-type, totalization meter.
2. Body: Bronze.
3. Minimum Working-Pressure Rating: 100 psig.
4. Maximum Pressure Loss at Design Flow: 3 psig.
5. Registration: Gallons or cubic feet.
6. End Connections: Threaded.
7. Control: Low-voltage signal capable of transmitting 1000 feet.

C. Water Meter:

1. AWWA C701, turbine-type, totalization meter.
2. Body: [Bronze] [Epoxy-coated cast iron].
3. Minimum Working-Pressure Rating: 150 psig.
4. Maximum Pressure Loss at Design Flow: 3 psig.
5. Registration: Gallons or cubic feet.
6. End Connections: Flanged.
7. Controls: Flow-control switch with normally open contacts; rated for maximum 10 A, 250-V ac; and that will close at adjustable increments of total flow.

D. Conductivity Controller:

1. Microprocessor-based controller, 1 percent accuracy in a range from zero to 5000 micromhos. Incorporate solid-state integrated circuits and digital LCD display in NEMA 250, Type 12 enclosure with gasketed and lockable door.
2. Digital display and touch pad for input.
3. Sensor probe adaptable to sample stream manifold.
4. High, low, and normal conductance indication.
5. High or low conductance alarm light, trip points field adjustable; with silence switch.
6. Hand-off-auto switch for solenoid bleed-off valve.
7. Bleed-off valve activated indication.
8. Internal adjustable hysteresis or dead-band.
9. Bleed Valves:
   a. Cooling Systems: Forged-brass body, globe pattern, general-purpose solenoid with continuous-duty coil, or motorized valve.
   b. Steam Boilers: Motorized ball valve, steel body, and TFE seats and seals.
10. Inhibitor Injection Timers:
    a. Microprocessor-based controller with LCD display in NEMA 250, Type 12 enclosure with gasketed and lockable door.[Interface for start/stop and status indication at central workstation as described in Section 230900 "Instrumentation and Control for HVAC."]

b. Programmable timers with infinite adjustment over full range, and mounted in cabinet with hand-off-auto switches and status lights.
c. Test switch.
d. Hand-off-auto switch for chemical pump.
e. Illuminated legend to indicate feed when pump is activated.
f. Programmable lockout timer with indicator light. Lockout timer to deactivate the pump and activate alarm circuits.
g. LCD makeup totalizer to measure amount of makeup and bleed-off water from two water meter inputs.

11. Biocide Feeder Timer:

a. Microprocessor-based controller with digital LCD display in NEMA 250, Type 12 enclosure with gasketed and lockable door.[Interface for start/stop and status indication at central workstation as described in Section 230900 "Instrumentation and Control for HVAC."]
b. 24-hour timer with 14-day skip feature to permit activation any hour of day.
c. Precision, solid-state, bleed-off lockout timer and clock-controlled biocide pump timer. Prebleed and bleed lockout timers.
d. Solid-state alternator to enable use of two different formulations.
e. 24-hour display of time of day.
f. 14-day display of day of week.
g. Battery backup so clock is not disturbed by power outages.
h. Hand-off-auto switches for biocide pumps.
i. Biocide A and Biocide B pump running indication.

E. Chemical Solution Tanks:

1. Chemical-resistant reservoirs fabricated from high-density opaque polyethylene with minimum 110 percent containment vessel.
2. Molded cover with recess for mounting pump.
3. Capacity:
   a. 30 gal.

F. Chemical Solution Injection Pumps:

1. Self-priming, positive-displacement; rated for intended chemical with minimum 25 percent safety factor for design pressure and temperature.
2. Adjustable flow rate.
3. Metal and thermoplastic construction.
4. Built-in relief valve.
5. Fully enclosed, continuous-duty, single-phase motor. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."

G. Chemical Solution Tubing: Polyethylene tubing with compression fittings and joints except ASTM A 269, Type 304, stainless steel for steam boiler injection assemblies.

H. Injection Assembly:

1. Quill: Minimum NPS 1/2 with insertion length sufficient to discharge into at least 25 percent of pipe diameter.
2. Ball Valve: Stainless steel as described in "Stainless-Steel Pipes and Fittings" Article below; and selected to fit quill.
   a. Two-piece.
3. Packing Gland: Mechanical seal on quill of sufficient length to allow quill removal during system operation.
4. Assembly Pressure/Temperature Rating: Minimum 600 psig at 200 deg F.

2.4 STAINLESS-STEEL PIPES AND FITTINGS

A. Stainless-Steel Tubing: Comply with ASTM A 269, Type 316.

B. Stainless-Steel Fittings: Complying with ASTM A 815/A 815M, Type 316, Grade WP-S.

C. Two-Piece, Full-Port, Stainless-Steel Ball Valves: ASTM A 351, Type 316 stainless-steel body; ASTM A 276, Type 316 stainless-steel stem and vented ball, carbon-filled TFE seats, threaded body design with adjustable stem packing, threaded ends, and 250-psig SWP and 600-psig CWP ratings.

D. Three-Piece, Full-Port, Stainless-Steel Ball Valves: ASTM A 351, Type 316 stainless-steel body; ASTM A 276, Type 316 stainless-steel stem and vented ball, threaded body design with adjustable stem packing, threaded ends, and 150-psig SWP and 600-psig CWP rating.

2.5 CHEMICAL TREATMENT TEST EQUIPMENT

A. Test Kit: Manufacturer-recommended equipment and chemicals in a wall-mounting cabinet for testing pH, Conductivity, inhibitor, chloride, alkalinity, and hardness; sulfite and testable polymer tests for high-pressure boilers, and oxidizing biocide test for open cooling systems.

B. Sample Cooler:

1. Tube: Sample.

   a. Size: NPS 1/4 tubing.
   b. Material: ASTM A 666, Type 316 stainless steel.
   c. Pressure Rating: Minimum 2000 psig.
   d. Temperature Rating: Minimum 850 deg F.

2. Shell: Cooling water.

   a. Material: ASTM A 666, Type 304 stainless steel.
   b. Pressure Rating: Minimum 250 psig.
   c. Temperature Rating: Minimum 450 deg F.

3. Capacities and Characteristics:

a. Tube: Sample.

1) Flow Rate: 0.25 gpm.
2) Entering Temperature: 400 deg F.
3) Leaving Temperature: 88 deg F.
4) Pressure Loss: 6.5 psig.

b. Shell: Cooling water.

1) Flow Rate: 3 gpm.
2) Entering Temperature: 70 deg F.
3) Pressure Loss: 1.0 psig.

C. Corrosion Test-Coupon Assembly: Constructed of corrosive-resistant material, complete with piping, valves, and mild steel and copper coupons. Locate copper coupon downstream from mild steel coupon in the test-coupon assembly.

1. Three-station rack for both open and closed-loop systems.

2.6 CHEMICALS

A. Chemicals shall be as recommended by water-treatment system manufacturer that are compatible with piping system components and connected equipment, and that can attain water quality specified in Part 1 "Performance Requirements" Article.

B. Water Softener Chemicals:

1. Mineral: High-capacity, sulfonated-polystyrene ion-exchange resin that is stable over entire pH range with good resistance to bead fracture from attrition or shock. Resin exchange capacity minimum 30,000 grains/cu. ft. of calcium carbonate of resin when regenerated with 15 lb of salt.
2. Salt for Brine Tanks: High-purity sodium chloride, free of dirt and foreign material. Rock and granulated forms are not acceptable.

2.7 FILTRATION EQUIPMENT

A. Multimedia Filters:
1. See Editing Instruction No. 1 in the Evaluations for cautions about naming manufacturers and products. Retain one of first three subparagraphs and list of manufacturers below. See Section 016000 "Product Requirements."
2. Delete first three subparagraphs and list below if retaining Part 2 "Manufacturers" Article.
3. VBFA COMMENT: from C. Hammond (Power Engineering) 130722;

4. Centrifugal filters seem to work best on open cooling systems. Sand filters tend to promote biological growth on the interface which can be persistent and diffucult to control.

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

   a. Griswold Controls.
   b. LAKOS; Claude Laval Corporation.
   c. PEP Filters, Inc.
   d. Puroflux Corporation.

6. Description: Factory-fabricated and -tested, simplex, multimedia filter system of filter tank, media, strainer, circulating pump, piping, and controls for removing particles from water.

   a. Filter Tank: Corrosion resistant with distribution system and media.

      1) Fabricate and label steel filter tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
      2) Fabricate and label FRP filter tanks to comply with ASME Boiler and Pressure Vessel Code: Section X, if indicated.
      3) Pipe Connections NPS 2 and Smaller: Threaded according to ASME B1.20.1.
      4) Steel Tank Pipe Connections NPS 2-1/2 and Larger: Steel, Class 150 flanges according to ASME B16.5 or grooved according to AWWA C606.
      5) FRP Tank Pipe Connections NPS 2-1/2 and Larger: Type A, integral; of grade same as tank material according to ASTM D 5421 and the following:
         a) Designation E, 125-psig or F, 150-psig pressure category flanges.

   b. Motorized Valves: Flanged or grooved-end, ductile-iron butterfly type with EPDM valve seat and stem seal; with ASTM B 148 aluminum bronze disc.
   c. Strainer: Basket type mounted on pump suction.
   d. Piping: ASTM A 53, Type S, F, or E; Grade B, Schedule 40 black steel, with flanged, grooved, or threaded joints and malleable, steel welding, or ductile-iron fittings.
   e. Piping: ASTM B 88, Type L copper water tube, copper-alloy solder-joint fittings, and brazed, flanged, or grooved joints.
   f. Safety Valves: Automatic pressure relief.
   g. Circulating Pump: Overhung impeller, close coupled, single stage, end suction, centrifugal. Comply with UL 778 and with HI 1.1-1.2 and HI 1.3.

      1) Casing: Radially split, cast iron.
      2) Pressure Rating: 125 psig minimum.
      3) Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, closed, and keyed to shaft.

4) Shaft and Shaft Sleeve: Steel shaft, with copper-alloy shaft sleeve.
5) Seal: Mechanical.
6) Motor: ODP motor supported on the pump-bearing frame. General requirements for motors are specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

h. Controls: Automatic control of circulating pump and tank backwash; factory wired for single electrical connection.

1) Panel: NEMA 250, Type 4 enclosure with time clock and pressure gages.
2) Pump: Automatic and manual switching; manual switch position bypasses safeties and controls.
3) Backwash: Automatic; with time clock and differential pressure switch.
4) Backwash Valve: Tank mounted with valves interlocked to single actuator.

i. Support: Skid mounting.

7. Capacities and Characteristics: (See Drawing Schedules.)

B. Self-Cleaning Strainers:

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

a. Everfilt.
b. Hayward Flow Control; a division of Hayward Industries, Inc.
c. Islip Flow Controls Inc.
d. Orival, Inc.
e. Sure Flow Equipment Inc.

2. Description: Factory-fabricated and -tested, ASTM A 126, Class B, cast-iron or steel, self-cleaning strainer system of tank, strainer, backwash arm or cleaning spiral, drive and motor, piping, and controls for removing particles from water.

a. Fabricate and label ASTM A 126, Class B, cast-iron or steel strainer tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
b. Pipe Connections:

1) NPS 2 and Smaller: Threaded according to ASME B1.20.1.
2) NPS 2-1/2 and Larger: Steel, Class 150 flanges according to ASME B16.5 or grooved according to AWWA C606.

3. Motorized Valves: Flanged or grooved-end, ductile-iron angle type with EPDM valve seat and stem seal; with ASTM B 148 aluminum bronze disc.
4. Strainer: ASTM A 666, Type 316 stainless steel.
5. Piping: ASTM A 53, Type S, F, or E; Grade B, Schedule 40 black steel, with flanged, grooved, or threaded joints and malleable, steel welding, or ductile-iron fittings.
6. Safety Valves: Automatic pressure relief.

7. Backwash Arm Drive:

    a. Drive Casing: Cast iron.
    b. Worm Gears: Immersed in oil.
    c. Motor: ODP motor supported on the strainer-bearing frame. General requirements for motors are specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

8. Controls: Automatic control of backwash; factory wired for single electrical connection.

    a. Panel: NEMA 250, Type 4 enclosure with time clock and pressure gages.
    b. Backwash Arm Drive: Automatic and manual switching; manual switch position bypasses safeties and controls.
    c. Backwash: Automatic; with time clock and differential pressure switch.
    d. Backwash Valve: Electric actuator.

9. Support: Skid mounting.

C. Centrifugal Separators:

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

    a. Griswold Controls.
    b. LAKOS; Claude Laval Corporation.
    c. PEP Filters, Inc.
    d. Puroflux Corporation.
    e. Rosedale Products, Inc.

2. Description: Simplex separator housing with baffles and chambers for removing particles from water by centrifugal action and gravity.
3. Housing: With manufacturer's proprietary system of baffles and chambers.

    a. Construction: Fabricate and label steel separator housing to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
    b. Inlet: Designed with tangential entry to produce centrifugal flow of feedwater.
    c. Vortex Chamber: Designed for downward vortex flow and gravity separation of particles.
    d. Collection Chamber: Designed to hold separated particles.
    e. Outlet: Near top of unit.
    f. Purge: At bottom of collection chamber.
    g. Pipe Connections NPS 2 and Smaller: Threaded according to ASME B1.20.1.
    h. Pipe Connections NPS 2-1/2 and Larger: Steel, Class 150 flanges according to ASME B16.5 or grooved according to AWWA C606. Provide stainless-steel flanges if tank is stainless steel.

4. Strainer: Stainless-steel basket type mounted on pump suction.

5. Piping: ASTM A 53, Type S, F, or E; Grade B, Schedule 40 black steel, with flanged, grooved, or threaded joints and malleable, steel welding, or ductile-iron fittings.
6. Piping: ASTM B 88, Type L copper water tube, copper-alloy solder-joint fittings, and brazed, flanged, or grooved joints.
7. Circulating Pump: Overhung impeller, close coupled, single stage, end suction, centrifugal. Comply with UL 778 and with HI 1.1-1.2 and HI 1.3.
    a. Casing: Radially split, cast iron.
    b. Pressure Rating: 125 psig minimum.
    c. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, closed, and keyed to shaft.
    d. Shaft and Shaft Sleeve: Steel shaft, with copper-alloy shaft sleeve.
    e. Seal: Mechanical.
    f. Motor: ODP motor supported on the pump-bearing frame. General requirements for motors are specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
8. Controls: Automatic control of circulating pump and separator purge; factory wired for single electrical connection.
    a. Panel: NEMA 250, Type 4 enclosure.
    b. Pump: Automatic and manual switching; manual switch position bypasses safeties and controls.
    c. Separator Purge: Automatic and manual.
    d. TDS Controller Interlock: Open separator purge valve with bleed-off control.
9. Support: Skid mounting.

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. Responsibilities:
    1. Water Treatment Contractor:
        a. Provide water treatment equipment.
        b. Provide fluids,
        c. Chemicals.
        d. Make adjustments.
    2. Mechanical Contractor:
        a. Install equipment per Water Treatment Contractors instructions.

B. 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.

C. Install seismic restraints for equipment and floor-mounting accessories and anchor to building structure. Refer to Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraints.

D. Install water testing equipment on wall near water chemical application equipment.

E. Install interconnecting control wiring for chemical treatment controls and sensors.

F. Mount sensors and injectors in piping circuits.

G. Bypass Feeders:

1. Install in closed hydronic systems, including:

   a. Hot-water heating.
   b. Chilled water.

2. Equipped with the following:
   a. Install bypass feeder in a bypass circuit around circulating pumps, unless otherwise indicated on Drawings.
   b. Retain first subparagraph below for closed systems larger than 400 gpm .
   c. Install water meter in makeup water supply.
   d. Install test-coupon assembly in bypass circuit around circulating pumps, unless otherwise indicated on Drawings.
   e. Install a gate or full-port ball isolation valves on inlet, outlet, and drain below feeder inlet.
   f. Install a swing check on inlet after the isolation valve.

H. Install automatic chemical-feed equipment for steam boiler and steam condensate systems and include the following:

1. Install makeup water softener.
2. Install water meter in makeup water supply.
3. Install inhibitor injection pumps and solution tanks with injection timer sensing contacts in water meter.

   a. Pumps shall operate for timed interval when contacts close at water meter in makeup water supply connection. Injection pump shall discharge into boiler feedwater tank or feedwater supply connection at boiler.

4. Install test equipment and furnish test-kit to Owner.
5. Install RO unit for makeup water.
6. Install Conductivity controller with sensor and bleed valves.

   a. Bleed valves shall cycle to maintain maximum Conductivity concentration.

7. Install inhibitor injection timer with injection pumps and solution tanks.

    a. Pumps shall operate for timed interval on contact closure at water meter in makeup water supply connection. Injection pump shall discharge into main steam supply header.

I. Install automatic chemical-feed equipment for condenser water and include the following:
1. Install water meter in makeup water supply.
2. Install inhibitor injection pumps and solution tanks with injection timer sensing contacts in water meter.

    a. Pumps shall operate for timed interval on contact closure at water meter in makeup water supply connection. Injection pump shall discharge into condenser water treatment sample line. Treatment shall be injected at a rate to sufficiently mix with sample water prior to injection into the condenser piping.

3. Install test equipment and provide test-kit to Owner. Install test-coupon assembly in bypass circuit around circulating pumps, unless otherwise indicated on Drawings.
4. Install TDS controller with sensor and bleed valves.

    a. Bleed valves shall cycle to maintain maximum Conductivity concentration.

5. Install pH sensor and controller with injection pumps and solution tanks.

    a. Injector pumps shall operate to maintain required pH.

6. Install biocide feeder alternating timer with two sets of injection pumps and solution tanks.

    a. Injection pumps shall operate to feed biocide on an alternating basis.

7. Install ozone generator with diffusers in condenser-water piping.

    a. Ozone generator shall operate continuously with condenser-water flow.

8. Install UV-irradiation lamps in condenser-water piping.

    a. UV lights shall operate continuously with condenser-water flow.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

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

C. Make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings. Dielectric fittings are specified in 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. Refer to Section 221119 "Domestic Water Piping Specialties" for backflow preventers required in makeup water connections to potable-water systems.

F. Confirm applicable electrical requirements in electrical Sections for connecting electrical equipment.

G. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

H. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

B. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Inspect field-assembled components and equipment installation, including piping and electrical connections.
2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
3. Place HVAC water-treatment system into operation and calibrate controls during the preliminary phase of HVAC systems' startup procedures.
4. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
5. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
6. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.

7. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.
8. Repair leaks and defects with new materials and retest piping until no leaks exist.

D. Remove and replace malfunctioning units and retest as specified above.

E. Sample boiler water at one-week intervals after boiler startup for a period of five weeks, and prepare test report advising Owner of changes necessary to adhere to Part 1 "Performance Requirements" Article for each required characteristic. Sample boiler water at four-week intervals following the testing noted above to show that automatic chemical-feed systems are maintaining water quality within performance requirements specified in this Section.

F. At four week intervals following Substantial Completion, perform separate water analyses on hydronic systems to show that automatic chemical-feed systems are maintaining water quality within performance requirements specified in this Section. Submit written reports of water analysis advising Owner of changes necessary to adhere to Part 1 "Performance Requirements" Article.

G. Comply with ASTM D 3370 and with the following standards:

1. Silica: ASTM D 859.
2. Steam System: ASTM D 1066.
3. Acidity and Alkalinity: ASTM D 1067.
4. Iron: ASTM D 1068.
5. Water Hardness: ASTM D 1126.

3.5 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. Refer to Section 017900 "Demonstration and Training."

B. Training: Provide a "how-to-use" self-contained breathing apparatus video that details exact operating procedures of equipment.

END OF SECTION 232500

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 and flat-oval ducts and fittings.
3. Double-wall round and flat-oval ducts and fittings.
4. Sheet metal materials.
5. Duct liner.
6. Sealants and gaskets.
7. Hangers and supports.

B. Related Sections:

1. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Section 233300 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.
3. Section 230713 “Duct Insulation” for duct insulation and fire wrap.

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. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of the following products:

1. Liners and adhesives.
2. Sealants and gaskets.

B. LEED Submittals:

1. Product Data for Prerequisite IEQ 1: Documentation indicating that duct systems comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."
2. Product Data for Prerequisite EA 2: Documentation indicating that duct systems comply with ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."
3. Leakage Test Report for Prerequisite EA 2: Documentation of work performed for compliance with ASHRAE/IESNA 90.1, Section 6.4.4.2.2 - "Duct Leakage Tests."
4. Duct-Cleaning Test Report for Prerequisite IEQ 1: Documentation of work performed for compliance with ASHRAE 62.1, Section 7.2.4 - "Ventilation System Start-up."
5. Laboratory Test Reports for Credit IEQ 4: For adhesives and sealants, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
6. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content.

C. 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.

D. Delegated-Design Submittal:

1. Sheet metal thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports.
5. Design Calculations: Calculations for selecting hangers and supports.

1.5 INFORMATIONAL SUBMITTALS

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

1. 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, but not limited to the following:

    a. Lighting fixtures.
    b. Air outlets and inlets.
    c. Speakers.
    d. Sprinklers.
    e. Access panels.
    f. Perimeter moldings.

B. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.

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

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
3. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."

D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, 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 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 DOUBLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. Rectangular Ducts: Fabricate ducts with indicated dimensions for the inner duct.

B. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

C. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

E. 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 Fat 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.

F. Interstitial Insulation: Flexible elastomeric duct liner complying with ASTM C 534, Type II for sheet materials, and with NFPA 90A or NFPA 90B.

1. Maximum Thermal Conductivity: 0.25 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.

G. Inner Duct: Minimum 0.028-inch perforated galvanized sheet steel having 3/32-inch-diameter perforations, with overall open area of 23 percent. Inner duct shall be solid sheet steel a minimum of 10 feet downstream of humidifiers or air washers.

H. Formed-on Transverse Joints (Flanges): Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Traverse 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."

I. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 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.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.

C. Longitudinal Seams: Not allowed.

D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.4 DOUBLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

A. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension) of the inner duct.

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 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

   a. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.

2. Longitudinal Seams: Not allowed.

3. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Inner Duct: Minimum 0.028-inch perforated galvanized sheet steel having 3/32-inch-diameter perforations, with overall open area of 23 percent.

1. Inner duct shall be solid sheet steel a minimum of 10 feet downstream of humidifiers and/or air washers.

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. Interstitial Insulation: Flexible elastomeric duct liner complying with ASTM C 534, Type II for sheet materials, and with NFPA 90A or NFPA 90B.

1. Maximum Thermal Conductivity: 0.25 Btu x in./h x sq. ft. x deg Fat 75 deg F mean temperature.

2.5 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.

1. Galvanized Coating Designation: G90.
2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Reinforcement Shapes and Plates: ASTM A 36, steel plates, shapes, and bars; black and galvanized.

1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

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.

2.6 DUCT LINER

A. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

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

a. CertainTeed Corporation; Insulation Group.
b. Johns Manville.
c. Knauf Insulation.
d. Owens Corning.

2. Maximum Thermal Conductivity:

a. Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
b. Type II, Rigid: 0.23 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.

3. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
4. Water-Based Liner Adhesive:
   a. Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
   b. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. 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, provide products by one of 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, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Insulation Pins and Washers:

1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, , length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
   a. 0.135-inch-diameter shank.
2. Insulation-Retaining Washers: With beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
   a. Self-locking washers formed from 0.016-inch-thick aluminum.

D. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation."

1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
3. Butt transverse joints without gaps, and coat joint with adhesive.
4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.

5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm
7. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inchestransversely; at 3 inchesfrom transverse joints and at intervals not exceeding 18 incheslongitudinally.
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 fpmor 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 build-outs (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

2.7 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: 4 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, sealant shall have 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, stainless steel, or aluminum sheets.

D. Solvent-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Base: Synthetic rubber resin.
3. Solvent: Toluene and heptane.
4. Solids Content: Minimum 60 percent.
5. Shore A Hardness: Minimum 60.
6. Water resistant.
7. Mold and mildew resistant.
8. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
9. VOC: Maximum 395 g/L.
10. Maximum Static-Pressure Class: 10-inch wg, positive or negative.
11. Service: Indoor or outdoor.
12. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

E. 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, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

F. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

G. 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.

2.8 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

F. 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.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install round and flat-oval 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 Section 233300 "Air Duct Accessories" for fire and smoke dampers.

L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines" .

3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. 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."
2. Outdoor, Supply-Air Ducts: Seal Class A.
3. Outdoor, Exhaust Ducts: Seal Class A.
4. Outdoor, Return-Air Ducts: Seal Class A.
5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class A.
6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
7. Unconditioned Space, Exhaust Ducts: Seal Class A.
8. Unconditioned Space, Return-Air Ducts: Seal Class A.
9. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class A.
10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
11. Conditioned Space, Exhaust Ducts: Seal Class A.
12. Conditioned Space, Return-Air Ducts: Seal Class A.

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.

3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inchesthick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inchesthick.
5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.5 SEISMIC-RESTRAINT-DEVICE INSTALLATION

A. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes. Comply with the requirements specified in Section 230548 "Vibration and Seismic Controls for HVAC."
1. Comply with ASCE/SEI 7.

3.6 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.7 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 Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:

1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
2. Test the following systems:

   a. Ducts with a Pressure Class Higher Than 3-Inch wg: Test representative duct sections, selected by Architect from sections installed, totaling no less than 25 percent of total installed duct area for each designated pressure class.
   b. Supply Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections, selected by Architect from sections installed, totaling no less than 50 percent of total installed duct area for each designated pressure class.
   c. Return Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections, selected by Architect from sections installed, totaling no less than 50 percent of total installed duct area for each designated pressure class.
   d. Exhaust Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections, selected by Architect from sections installed, totaling no less than 50 percent of total installed duct area for each designated pressure class.
   e. Outdoor Air Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections, selected by Architect from sections installed, totaling no less than 50 percent of total installed duct area for each designated pressure class.

3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
4. Test for leaks before applying external insulation.
5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
6. Give seven days' advance notice for testing.

C. Duct System Cleanliness Tests:

1. Visually inspect duct system to ensure that no visible contaminants are present.
2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."

   a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.

3. Any liner showing evidence that is has wet at any time shall be removed and replaced with new liner.
   a. Disinfect affected sheet metal, and pins.

b. Install new liner per specifications
c. Seal friable edges and seams of repaired liner.

D. Duct system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.9 DUCT CLEANING

A. Clean new duct system before testing, adjusting, and balancing.

B. Use service openings for entry and inspection.

1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 233300 "Air Duct Accessories" for access panels and doors.
2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling to gain access during the cleaning process.

C. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

D. Clean the following components by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.

E. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.

2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide drainage and cleanup for wash-down procedures.
7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.10 START UP

A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.11 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:
   1. Underground ducts shall be as specified in Section 233116 "Nonmetal Ducts" for fibrous-glass ducts, thermoset fiber-reinforced plastic ducts, thermoplastic ducts, PVC ducts, and concrete ducts.

B. Ductwork running in areas where there are no ceilings or when noted on the drawings shall be doubled wall duct and shall meet the requirements indicated below.

C. Supply Ducts:

   1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:

      a. Pressure Class: Positive 2-inch wg.

      b. Minimum SMACNA Seal Class: A.
      c. Minimum SMACNA Seal Class: A.

      d. SMACNA Leakage Class for Rectangular: 16.

      e. SMACNA Leakage Class for Round: 8.

   2. Ducts Connected to Variable-Air-Volume Air-Handling Units:

      a. Pressure Class: Positive 6-inch wg.

b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 4.
d. SMACNA Leakage Class for Round: 2.

3. Ducts Connected to Equipment Not Listed Above:

a. Pressure Class: Positive 4-inch wg.
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 4.
d. SMACNA Leakage Class for Round: 2.

D. Return Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:

a. Pressure Class: Positive or negative 2-inch wg.
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 16.
d. SMACNA Leakage Class for Round: 8.

2. Ducts Connected to Air-Handling Units:

a. Pressure Class: Positive or negative 2-inch wg.
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 16.
d. SMACNA Leakage Class for Round: 8

3. 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: 8.
d. SMACNA Leakage Class for Round: 4.

E. Exhaust Ducts:

1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:

a. Pressure Class: Negative 2-inch wg.
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 16.

d. SMACNA Leakage Class for Round: 4.

2. Ducts Connected to Equipment Not Listed Above:

a. Pressure Class: Positive or negative 4-inch wg.
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 4 .
d. SMACNA Leakage Class for Round: 2 .

F. Outdoor-Air and Combustion Air (Not Filtered, Heated, or Cooled) Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:

a. Pressure Class: Positive or negative 2-inch wg.
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 16 .
d. SMACNA Leakage Class for Round and Flat Oval: 4.

2. Ducts Connected to Air-Handling Units:

a. Pressure Class: Positive or negative 3-inch wg.
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 8.
d. SMACNA Leakage Class for Round: 4.

3. 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: 8.
d. SMACNA Leakage Class for Round: 4.

G. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel.

2. PVC-Coated Ducts:

a. Exposed to Airstream: Match duct material.
b. Not Exposed to Airstream: Match duct material.

3. Stainless-Steel Ducts:

   a. Exposed to Airstream: Match duct material.
   b. Not Exposed to Airstream: Match duct material.

4. Aluminum Ducts: Aluminum.

H. Liner:

1. Supply Air Ducts: Fibrous glass, Type I, 1 inch thick.
2. Return Air Ducts: Fibrous glass, Type I, 1 inch thick.
3. Exhaust Air Ducts: Fibrous glass, Type I, 1 inch thick.
4. Supply Fan Plenums: Fibrous glass, Type I, 1 inch thick.
5. Return- and Exhaust-Fan Plenums: Fibrous glass, Type II, 1 inch thick.
6. Transfer Ducts: Fibrous glass, Type I [or flexible elastomeric], 1 inch thick.

I. Double-Wall Duct Interstitial Insulation:

1. Supply Air Ducts: 1 inch thick.
2. Return Air Ducts: 1 inch thick.
3. Exhaust Air Ducts: 1 inch thick.

J. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

   a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
   b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
   c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."

   a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.

      1) Velocity 1000 fpm or Lower: 1.0 radius-to-diameter ratio and three segments for 90-degree elbow.
      2) Velocity 1000 to 1500 fpm: 1.5 radius-to-diameter ratio and four segments for 90-degree elbow.

3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
4) Radius-to Diameter Ratio: 1.5.

b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
c. Round Elbows, 14 Inches and Larger in Diameter: Welded.

K. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."

a. Rectangular Main to Rectangular Branch: 45-degree entry high efficiency take-off.

b. Rectangular Main to Round Branch: 45-degree entry high efficiency take-off.

2. Round:

a. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.
b. Velocity 1000 to 1500 fpm: 45-degree entry high efficiency 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. Barometric relief dampers.
2. Manual volume dampers.
3. Fire dampers.
4. Smoke dampers.
5. Combination fire and smoke dampers.
6. Turning vanes.
7. Remote damper operators.
8. Duct-mounted access doors.
9. Flexible connectors.
10. Flexible ducts.
11. Duct accessory hardware.
12. High efficiency take-offs.

B. Related Requirements:

1. Division 23 "HVAC Gravity Ventilators" for roof-mounted ventilator caps.
2. Division 23 “Diffusers, Registers and Grilles”.
3. Division 28 "Digital, Addressable Fire-Alarm System" for duct-mounted fire and smoke detectors.
4. Division 28 "Zoned (DC-Loop) Fire-Alarm System" for duct-mounted fire and smoke detectors.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.

B. LEED Submittals:

1. Product Data for Prerequisite IEQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."
2. Product Data for Prerequisite EA 2: Documentation indicating that duct insulation R-values comply with tables in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air Conditioning."

C. 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, pressure relief-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
e. Wiring Diagrams: For power, signal, and control wiring.

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.

B. Source quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

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

1. Fusible Links: Furnish quantity equal to **10** percent of amount installed.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 MATERIALS

A. Galvanized Sheet Steel: Comply with ASTM A 653.
   1. **Galvanized Coating Designation: G60**.
   2. Exposed-Surface Finish: Mill phosphatized.

B. Aluminum Sheets: Comply with **ASTM B 209**, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

C. Extruded Aluminum: Comply with **ASTM B 221**, Alloy 6063, Temper T6.

D. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

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**.

2.3 BAROMETRIC RELIEF DAMPERS

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

   1. American Warming and Ventilating; a division of Mestek, Inc.
   2. Greenheck Fan Corporation.
   3. Nailor Industries Inc.
   4. Pottorff.

B. Function:
   1. Senses and compares outdoor ambient and indoor pressures.
   2. Allows any higher pressure indoor air to escape.

C. Description: Suitable for horizontal or vertical mounting.

D. Maximum Air Velocity:
   1. 1000 fpm

E. Maximum System Pressure:
   1. 3-inch wg .

F. Frame: Hat-shaped, with welded corners or mechanically attached and mounting flange.
   1. **13GA 0.094-inch- thick, galvanized sheet steel**.

G. Blades: Multiple:
   1. [16GA 0.050-inch- thick aluminum sheet] .
   2. Maximum Width: **6 inches**.
   3. Action: Parallel.
   4. Balance: Gravity.
   5. Pivot:
      a. Eccentric.

H. Blade Seals:
   1. Neoprene

I. Blade Axles:
   1. Galvanized steel .

J. Tie Bars and Brackets: Rattle free with 90-degree stop.
   1. Material:
      a. Galvanized steel .

K. Return Spring: Adjustable tension.

L. Bearings:
   1. Synthetic

2.4 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:

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

      a. American Warming and Ventilating; a division of Mestek, Inc.
      b. McGill AirFlow LLC.
      c. Nailor Industries Inc.
      d. Pottorff.
      e. United Enertech

   2. Standard leakage rating **, with linkage outside airstream** .
   3. Suitable for horizontal or vertical applications.

4. Frames: Hat-shaped, Mitered and welded corners. Flanges for attaching to walls and flangeless frames for installing in ducts.
   a. 16GA 0.064-inch thick, galvanized sheet steel.

5. Blades:
   a. Multiple or single blade. Parallel- or opposed-blade design. Stiffened damper blades for stability.
   b. Material:
      1) Galvanized -steel, 16GA 0.064 inch thick.

6. Blade Axles:
   a. Nonferrous metal
   b. Shall extend full length of damper blades in ducts with pressure classes of **3-inch wg** or more.

7. Bearings:
   a. Material:
      1) Molded synthetic.
   b. Bearings at both ends of damper operating shafts in ducts with pressure classes of **3-inch wg** or more.

8. Tie Bars and Brackets: Galvanized steel.

B. Low-Leakage, Steel, Manual Volume Dampers:

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

   a. American Warming and Ventilating; a division of Mestek, Inc.
   b. McGill AirFlow LLC.
   c. Nailor Industries Inc.
   d. Pottorff.
   e. Ruskin Company.
   f. United Enertech

2. Comply with AMCA 500-D testing for damper rating.
3. Low-leakage rating **, with linkage outside airstream,** and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
4. Suitable for horizontal or vertical applications.
5. Frames:
   a. Frame: Hat-shaped,
      1) **16GA 0.064-inch** thick, galvanized sheet steel.
   b. Mitered and welded corners.
   c. Flanges for attaching to walls and flangeless frames for installing in ducts.

6. Blades:

   a. Multiple or single blade.

b. Parallel- or opposed-blade design.
c. Stiffen damper blades for stability.
d. Material:
1) Galvanized, roll-formed steel, 16GA 0.064 inch thick.

7. Blade Axles:
a. Nonferrous metal.

8. Bearings:

a. **Molded synthetic**.
b. Dampers in ducts with pressure classes of **3-inch wg** or more shall have axles full length of damper blades and bearings at both ends of operating shaft.

9. Blade Seals:
a. Neoprene.
10. Jamb Seals: Cambered **Stainless steel** or **aluminum**.
11. Tie Bars and Brackets: **Galvanized steel** or **aluminum**.
12. Accessories:

a. Include locking device to hold single-blade dampers in a fixed position without vibration.

C. Jackshaft:

1. Size:
a. 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.

D. 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.

2.5 FIRE DAMPERS

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

1. Arrow United Industries; a division of Mestek, Inc.
2. Greenheck Fan Corporation.
3. Nailor Industries Inc.
4. Pottorff.

5. United Enertech

B. Type:
1. **Dynamic.**

C. Standard: Rated and labeled according to UL 555 by an NRTL.

D. Closing rating in ducts up to **4-inch wg** static pressure class and minimum **2000-fpm** velocity.

E. Fire Rating:
1. 1-1/2 hours.

F. Frame:
1. Curtain type with blades outside airstream.
2. Material:
a. Fabricated with roll-formed galvanized steel; with mitered and interlocking corners.
b. Thickness:
1) 20GA-0.040-inch-.

G. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel. Length to suit application.

1. Minimum Thickness:
a. 18GA-0.05 inch, as indicated.
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.

H. Mounting Orientation: Vertical or horizontal as indicated.

I. Blades: Roll-formed, interlocking, galvanized sheet steel.
1. Thickness:
a. **24GA-0.024-inch-**
2. In place of interlocking blades, use full-length, **0.034-inch-** thick, galvanized-steel blade connectors.

J. Horizontal Dampers: Include blade lock and Type 301 constant force stainless-steel closure spring.

K. **Heat-Responsive Device:** Replaceable, **212 deg F** rated, fusible links.

2.6 SMOKE DAMPERS

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

1. Greenheck Fan Corporation.
2. Nailor Industries Inc.
3. Pottorff.
4. United Enertech

B. General Requirements: Label according to UL 555S by an NRTL.

C. Smoke Detector: Integral, factory wired for single-point connection.

1. Type: Photoelectric.

D. Frame: Galvanized sheet steel. With or without mounting flange as required.
1. Thickness:
a. Hat-shaped, 16GA-0.064-inch.
2. Corners:
a. Welded.

E. Blades: Horizontal, galvanized sheet steel.
1. Section;
a. Roll-formed.
2. Fit:
a. Interlocking.
3. Thickness:
a. 14GA-0.079-inch.

F. Leakage:
1. Class II.

G. Seals:
1. Blade: Inflatable silicone fiberglass material to maintain smoke leakage rating to a minimum of **450 deg F** .

H. Rated pressure and velocity to exceed design airflow conditions.

I. Mounting Sleeve: Factory-installed, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone calking.
1. Minimum **17-inches** long.
2. Thickness:
a. **0.05-inch-**.

J. Damper Motors:
1. Action:
a. Two-position
2. Mode: Fail close.
3. Mounting: External.

K. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
   1. Electrical Connection: **115 V, single phase, 60 Hz** .

L. Accessories:

   1. Auxiliary switches for signaling:
      a. Position indication.
   2. Test Switch type:
      a. Momentary test switch.
   3. Test Switch Mounting:
      a. Damper.

2.7 COMBINATION FIRE AND SMOKE DAMPERS

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

   1. Greenheck Fan Corporation.
   2. Nailor Industries Inc.
   3. Pottorff.
   4. United Enertech

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 velocity of:
   1. **4000-fpm**

D. Fire Rating:
   1. 1-1/2 hours.

E. Frame: Hat shaped, galvanized sheet steel. With or without mounting flange as required.
   1. Thickness:
      a. 16GA-0.064-inch
   2. Corners:
      a. Welded.

F. **Heat-Responsive Device:** Replaceable, **212 deg F** rated, fusible links.

G. Blades: Horizontal, galvanized sheet steel.
   1. Type:
      a. Air-foil.
   2. Fit:,
      a. Interlocking.
   3. Thickness:
      a. 0.063-inch-.

H. Leakage:
   1. Class I.

I. Rated pressure and velocity to exceed design airflow conditions.

J. Mounting Sleeve: Factory-installed, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone calking.
   1. Thickness:
      a. **18GA 0.05-inch-**.

K. Master control panel for use in dynamic smoke-management systems.

L. Damper Motors:
   1. Locate outside air stream unless otherwise indicated,
   2. Action:
      a. Two-position.
   3. Voltage: to match fire alarm system (coordinate).
   4. Listed: UL, as part of damper assembly.
   5. Outdoor Motors and Motors in Outside-Air Intakes:
      a. Gaskets: O-ring gaskets designed to make motors weatherproof.
      b. Internal heaters: Equip to permit normal operation at minus **40 deg F** .

M. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
   1. Electrical Connection: 115 V, single phase, 60 Hz.

N. Accessories:

   1. Auxiliary switches:
      a. Signaling.
      b. Position indication.
   2. Test Switch type:
      a. Momentary test switch.
   3. Test Switch Mounting:
      a. Damper.

2.8 TURNING VANES

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

   1. METALAIRE, Inc.
   2. SEMCO Incorporated.
   3. 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. Fabricate single blade vanes to comply with SMACNA's "HVAC Duct Construction Standards-Metal and Flexible."

2. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

C. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

D. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."

E. Vane Construction: [**Single**] [**Double**] wall.

F. Vane Construction: Single wall for ducts up to **48 inches** wide and double wall for larger dimensions.

2.9 REMOTE DAMPER OPERATORS

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

1. Pottorff.
2. Ruskin Company; Tomkins PLC.
3. Young Regulator Company.

B. Cable Type:
1. Description: Cable system designed for remote manual damper adjustment.
2. Tubing/Sheathing: Galvinsed, Brass, Copper or Aluminum.
3. Cable: Stainless steel or Steel.
4. Wall-Box Mounting: Coordinate with Architect.
5. Wall-Box Cover-Plate Material: Coordinate with Architect.

C. Activated Electric Type:
1. Description: Electrically activated zone control damper for remote adjustment. When an adjustment is needed the system is powered up.
2. Means: Factory mounted actuator factory wired to damper.
3. Portable **9 volt** system. No field power requirement.
4. Mounting: Recessed Wall Box or Diffuser or Hand Held.
5. Wall-Box Cover Finish: Coordinate with Architect.
6. Wall-Box Porting: 1 to 6 ports or more.

2.10 DUCT-MOUNTED ACCESS DOORS

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

1. Greenheck Fan Corporation.
2. McGill AirFlow LLC.
3. Pottorff.
4. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures **7-2**, "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."

1. Door:

   a. Double wall, rectangular.
   b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
   c. Vision panel.
   d. Hinges and Latches: **1-by-1-inch** butt or piano hinge and cam latches.
   e. Fabricate doors airtight and suitable for duct pressure class.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
3. Number of Hinges and Locks:

   a. Access Doors Less Than **12 Inches** Square: No hinges and two sash locks.
   b. Access Doors up to [**18 Inches**] Square:
      1) Hinges:
         a) Two hinges and two sash locks.
   c. Access Doors up to **24 by 48 Inches**, provide outside and inside handles:
      1) Hinges:
         a) Three hinges and two compression latches.
   d. Access Doors Larger Than **24 by 48 Inches**, provide outside and inside handles:
      1) Hinges:
         a) Continuous and two compression latches with outside and inside handles.

2.11 FLEXIBLE CONNECTORS

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

1. Ductmate Industries, Inc.
2. Ventfabrics, Inc.
3. 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 wide fabric strip attached to two narrower metal strips. Provide strips of metal compatible with connected ducts.
   1. Wide Strip:
      a. 3-1/2 inches.
   2. Narrow Strips:
      a. 0.028-inch- thick, galvanized sheet steel.

E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

   1. Minimum Weight: **26 oz./sq. yd.**.
   2. **Tensile Strength**: **530 lbf/inch** in the warp and **440 lbf/inch** in the filling.
   3. Service Temperature: **Minus 40 to plus 200 deg F**.

F. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.

   1. Minimum Weight: **24 oz./sq. yd.**.
   2. Tensile Strength: **530 lbf/inch** in the warp and **440 lbf/inch** in the filling.
   3. Service Temperature: **Minus 50 to plus 250 deg F**.

2.12 FLEXIBLE DUCTS

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

   1. Flexmaster U.S.A., Inc.
   2. McGill AirFlow LLC.
   3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Ducts shall conform to the requirements for Class I connectors when tested in accordance with "Standard for Factory Made Air Ducts Materials and Air Duct Connectors" (UL 181).

C. Ducts shall also pass the 15 minute U.L. flame penetration test as specified in the UL 181 Standard.

D. Insulated, Flexible Duct: Two-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene or 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: [**Comply with ASHRAE/IESNA 90.1**].

E. Flexible Duct Connectors:

1. **Clamps**: in sizes **3 through 18 inches**, to suit duct size.
   a. **Material**: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action .

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.

C. Splitter Damper Accessories: Zinc-plated damper blade bracket; **1/4-inch**, zinc-plated operating rod; and a duct-mounted, ball-joint bracket with flat rubber gasket and square-head set screw.

D. Flexible Duct Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action, in sizes **3 to 18 inches** to suit duct size.

2.22 HIGH EFFICIENCY TAKE-OFFS

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

1. Hercules Industries
2. Sheet Metal Connectors, Inc.
3. Spiral Manufacturing Co. Inc.
4. Ferguson

B. Materials:

1. 24 gauge galvanized sheet metal meeting ASTM A653 and A924

C. Take-off shall meet SMACNA third edition Section 4.8 figure 4.6 - 45 degree entry.

D. Rectangular opening with flanged sides on all sides. Complete with closed cell neoprene gasket to provide a tight seal.

E. Zeros VOC's

PART 3 - EXECUTION

3.1 INSTALLATION

General

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Use the Remote Damper Operator when they are called out on the drawings or when the damper cannot be easily accessed.

D. Install high efficiency take-off on all branch duct take-offs. Provide take-off with balancing damper as shown on drawings. Spin-in fittings are not allowed.

Flexible Ducts / Flexible Duct Connectors

E. Install flexible connectors to connect ducts to equipment.

F. Flexible duct connections from the main trunk ducts to diffuser boots shall be furnished and installed as shown on the drawings. Flexible ductwork shall only be used as indicated on the drawings.

G. Where flexible duct is indicated, use insulated flexible duct for supply air return and exhaust air.

H. Flexible ductwork shall be run in straight lengths.

I. Provide support in flexible duct every three feet.

J. Flexible ducts shall have compression fittings on both ends.

K. Flexible ductwork is not allowed to bend 90 degrees. If a bend is needed use sheet-metal hard elbows. Hard turns, offsets, or kinks will not be allowed.

L. Flexible ducts shall connect to trunk duct with high efficiency takeoffs.

M. Connect flexible ducts to metal ducts with **draw bands**.

N. Connect ducts to duct silencers:
   1. With flexible duct connectors.

O. Connect terminal units to supply ducts:
   1. With maximum 12-inch lengths of flexible duct.

P. Do not use flexible ducts to change directions.

Q. Connect diffusers or light troffer boots to ducts:
1. **With maximum 60-inch** lengths of flexible duct clamped or strapped in place.

Backdraft/Control/Pressure Relief Dampers

R. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

S. Install pressure relief damper immediately upstream of main fire damper.

Volume Damper

T. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

1. Install steel volume dampers in steel ducts.
2. Install aluminum volume dampers in aluminum ducts.

U. Set dampers to fully open position before testing, adjusting, and balancing. Exception: Pressure relief damper.

V. A balance damper with locking quadrant will be provided downstream of take-off from trunk duct.

Fans And Test Holes

W. For fans developing static pressures of **5-inch wg** and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

X. 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.

Y. Install duct test holes where required for testing and balancing purposes.

Z. Install test holes at fan inlets and outlets and elsewhere as indicated.

FIRE, SMOKE AND FIRE-SMOKE DAMPERS

AA. Install fire **and smoke** dampers according to UL listing.
1. Install fusible links in fire dampers.

BB. For round ductwork **24-inch** and smaller a true round fire damper with the same rating may be used.

Access Doors

CC. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:

1. On both sides of duct coils.
2. **Upstream** from duct filters.
3. At outdoor-air intakes and mixed-air plenums.
4. At drain pans and seals.
5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be **standard access doors** and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
7. At each change in direction and at maximum **50-foot** spacing.
8. **Upstream** from turning vanes.
9. Upstream or downstream from duct silencers.
10. Control devices requiring inspection.
11. Elsewhere as indicated.

DD. Install access doors with swing against duct static pressure.

EE. Access Door Sizes:

1. One-Hand or Inspection Access: **8 by 5 inches**.
2. Two-Hand Access: **12 by 6 inches**.
3. Head and Hand Access: **18 by 10 inches**.
4. Head and Shoulders Access: **21 by 14 inches**.
5. Body Access: **25 by 14 inches**.
6. Body plus Ladder Access: **25 by 17 inches**.

FF. Label access doors according to Section 230553 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

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.

5. Operate remote damper operators to verify full range of movement of operator and damper.

3.3 ADJUSTING

A. Adjust duct accessories for proper settings.

B. Adjust fire and smoke dampers for proper action.

C. Final positioning of manual-volume dampers is specified in Division 23 Section "Testing, Adjusting, and Balancing for HVAC."

END OF SECTION 233300

SECTION 233423 - HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Ceiling-mounted ventilators.
   2. In-line centrifugal fans.

1.3 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base fan-performance ratings on:
   1. Actual Project site elevations.

B. Operating Limits: Classify according to AMCA 99.

C. Fan Schedule: Fan characteristics and performance data are described in an equipment schedule on the drawings including:
   1. Fan arrangement with wheel configuration, inlet and discharge configurations, and required accessories.
   2. Capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, shipping weights, operating weights, 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.
   a. Detail all wiring systems and differentiate clearly between manufacturer-installed and field-installed wiring.

1.5 INFORMATIONAL SUBMITTALS

A. 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.

B. Field quality-control Reports

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

1.7 MATERIALS MAINTENANCE SUBMITTALS

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

1. Belts: One set for each belt-driven unit.

1.8 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. NEMA Compliance: Power ventilator electrical components shall comply with applicable NEMA standards.

D. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.

1.9 COORDINATION

A. Coordinate size and location of structural-steel support members.

B. Coordinate sizes and locations of concrete bases with actual equipment provided.

C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

PART 2 - PRODUCTS

2.1 PRODUCTS FURNISHED BUT NOT INSTALLED

A. Products furnished, but not installed, under this Section include roof curbs for roof-mounted exhaust fans. Roof curbs to be installed by Division 07, section "Roof Accessories".

2.2 CEILING-MOUNTED VENTILATORS

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

1. Greenheck Fan Corporation.
2. PennBarry.
3. Twin City

B. Housing: Steel, lined with acoustical insulation.

C. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel shall be removable for service.

D. Grille: With flange on intake and thumbscrew attachment to fan housing.
1. **Painted steel.**

E. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.

2.3 IN-LINE CENTRIFUGAL FANS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Greenheck Fan Corporation.
   2. Hartzell Fan Incorporated.
   3. PennBarry.
   4. Twin City

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**:**
   1. Wheel, inlet cone.

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.
   1. Fan Guard: **1/2- by 1-inch** mesh of galvanized steel in removable frame. Provide guard for inlet or outlet on units not connected to ductwork, where contact with fan wheel is within personal reach through access opening, or where falling objects and/or debris may enter fan.

F. Accessories:
   1. Dampers:
      a. Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops**.**
      b. Motorized parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops. These dampers to be black in all cases.
   2. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.
   3. Disconnect Switch: Nonfusible type:
      a. Thermal-overload protection; factory wired through an internal aluminum conduit.
         1) Mounted inside fan housing.

2.4 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

   1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
   2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.

B. Enclosure Type: Totally enclosed;

1. Fan cooled

2.5 FACTORY FINISH

A. Metal Parts: All assembly parts shall be protected from rust and corrosion.
   1. Stainless steel, aluminum, and other non-corroding materials require no protective finish.
   2. Non-galvanized sheet metal parts shall be prime coated or powder coated before final assembly.
   3. Prime coated parts shall receive baked enamel finish coat after assembly.

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 EXAMINATION

A. Examine areas and conditions for compliance with requirements of installation tolerances and other conditions affecting performance of the power ventilators. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 PROJECT CONDITIONS

A. Field Measurements: Verify dimensions by field measurements. Verify clearances.

B. Do not operate fans until ductwork is clean, filters are in place, bearings are lubricated, and fans have been commissioned.

3.3 INSTALLATION

A. Install power ventilators level and plumb according to manufacturer's written instructions.

B. Base Mounted Equipment:

1. Install power ventilators on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in:
   a. Division 33 "Cast-in-Place Concrete."

C. Secure roof-mounted fans to roof curbs with cadmium-plated hardware. See Section 077200 "Roof Accessories" for installation of roof curbs.

D. Ceiling Units: Suspend units from structure; use steel wire or metal straps.

E. **Support Steel:** Support suspended units from structure using threaded steel as specified in Division 23 "Vibration and Seismic Controls for HVAC."

F. Label units according to requirements specified in Division 23 "Identification for HVAC Piping and Equipment."

G. Install power ventilators with factory recommended and code required clearances for service and maintenance.

3.4 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 Section 233300 "Air Duct Accessories."

B. Install ducts adjacent to power ventilators to allow service and maintenance.

C. Ground equipment according to Division 26 "Grounding and Bonding for Electrical Systems."
   1. Tighten electrical connectors and terminals, including grounding connections, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

D. Connect wiring according to Division 26 "Low-Voltage Electrical Power Conductors and Cables."
   1. Tighten electrical connectors and terminals, including grounding connections, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.5 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.

3.6 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Comply with requirements in Division 23 "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.

3.7 CLEANING

A. After completing installation, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes including chips, scratches, and abrasions.

B. Clean fan interiors to remove foreign material and construction debris. Vacuum clean fan wheel and cabinet.

3.8 DEMONSTRATION

A. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.

B. Review data in the operation and maintenance manuals. Refer to Division 1 Section "Contract Closeout."

C. Schedule training with Owner, through Architect, with at least 7 days' advance notice.

D. Demonstrate operation of power ventilators. Conduct walking tour of the Project. Briefly identify location and describe function, operation, and maintenance of each power ventilator.

END OF SECTION 233423

SECTION 233600 - AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Shutoff, single-duct air terminal units.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of the following products, including rated capacities, furnished specialties, sound-power ratings, and accessories.

1. Air terminal units.
2. Liners and adhesives.
3. Sealants and gaskets.
4. Seismic-restraint devices.

B. LEED Submittals:

1. Product Data for Prerequisite IEQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."

C. Shop Drawings: For air terminal units. 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:
   a. For power, signal, and control wiring.
   b. Differentiate between manufacturer-installed and field-installed wiring.
3. **Hangers and supports**, including methods for duct and building attachment and vibration isolation.

D. Delegated-Design Submittal:

1. Materials, fabrication, assembly, and spacing of hangers and supports.
2. **Design Calculations:** Calculations **, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation** for selecting hangers and supports.

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. Size and location of initial access modules for acoustic tile.
3. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Instructions for resetting minimum and maximum air volumes.
2. Instructions for adjusting software set points.

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-Powered-Unit Filters: Furnish **one** spare filter for each filter installed.

1.7 QUALITY ASSURANCE

A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."

B. Product Options: Drawings and schedules indicate requirements of air terminals and are based on specific systems indicated. Other manufacturers' systems with equal performance characteristics may be considered. Refer to Division 1 Section "Substitutions."

C. Listing and Labeling: Provide electrically operated air terminals specified in this Section that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in NFPA 70, Article 100.

D. NFPA Compliance: Install air terminals according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."

E. Comply with NFPA 70 for electrical components and installation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. **Structural Performance:** 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" .

2.2 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.

2.3 SHUTOFF, SINGLE-DUCT AIR TERMINAL UNITS

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

1. Anemostat Products; a Mestek Company.
2. Carnes.
3. Environmental Technologies, Inc.
4. METALAIRE, Inc.
5. Nailor Industries Inc.
6. Price Industries.
7. Titus.
8. Trox USA Inc.; a subsidiary of the TROX GROUP.
9. Tuttle & Bailey.
10. Warren Technology.

B. Configuration: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.

C. **Casing: 0.034-inch steel, single** wall.
1. **Casing Lining:** Adhesive attached, **coated, fibrous-glass duct liner** complying with ASTM C 1071, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.

a. Lining thickness:
1) **1/2-inch-**
b. Cover liner with nonporous foil.

2. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
3. Air Outlet: S-slip and drive connections.
4. Air Outlet: S-slip and drive connections **size matching inlet size**.
5. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.
6. (LEED) Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

D. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.

1. Maximum Damper Leakage:
a. ARI 880 rated, **3** percent of nominal airflow at **3-inch wg** inlet static pressure.
2. Damper Position:
a. Normally **open**.
3. (LEED) Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

E. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than **0.1 inch**, and rated for a minimum working pressure of **200 psig** and a maximum entering-water temperature of **220 deg F**. Include manual air vent and drain valve.

L. Direct Digital Controls: Bidirectional damper operators and microprocessor-based controller and room sensor. Control devices shall be compatible with temperature controls specified in Section 230900 "Instrumentation and Control for HVAC" and shall have the following features:

1. Damper Actuator: 24 V, powered closed, spring return open.
2. Terminal Unit Controller: Pressure-independent, variable-air-volume controller with electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes, and having the following features:

a. Occupied and unoccupied operating mode.
b. Remote reset of airflow or temperature set points.
c. Adjusting and monitoring with portable terminal.
d. Communication with temperature-control system specified in Section 230900 "Instrumentation and Control for HVAC."

3. Room Sensor: Wall mounted with temperature set-point adjustment and access for connection of portable operator terminal.

F. Control Sequence:

1. Suitable for operation with duct pressures between **0.25- and 3.0-inch wg** inlet static pressure.
2. System-powered, wall-mounted thermostat.

2.4 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. **Steel Cables: Galvanized steel complying with ASTM A 603**.

D. 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.

E. Air Terminal Unit Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

F. Trapeze and Riser Supports: Steel shapes and plates for units with steel casings; aluminum for units with aluminum casings.

2.5 SOURCE QUALITY CONTROL

A. Factory Tests: Test assembled air terminal units according to ARI 880.

1. Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, and ARI certification seal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."

B. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.

C. Install wall-mounted thermostats.

D. Install discharge air temperature sensors at the outlet of each Air Terminal Unit.

E. Connect ductwork to air terminals according to Division 23 ductwork Sections.

F. For Diffuser Type Air Terminal Units, provide and install all necessary control wiring and control voltage transformer. See drawings AND schedules for additional information.

3.2 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes and for slabs more than **4 inches** thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes and for slabs less than **4 inches** thick.
5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hangers Exposed to View: Threaded rod and angle or channel supports.

D. 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.

3.3 CONNECTIONS

A. Install piping adjacent to air terminal unit to allow service and maintenance.

B. Hot-Water Piping: In addition to requirements in Section 232113 "Hydronic Piping" and Section 232116 Hydronic Piping Specialties," connect heating coils to supply with shutoff valve, strainer, control valve, and union or flange; and to return with balancing valve and union or flange.

C. Connect ducts to air terminal units according to **Section 233113 "Metal Ducts.**

D. Make connections to air terminal units with flexible connectors complying with requirements in Section 233300 "Air Duct Accessories."

E. Electrically ground all equipment:
1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 IDENTIFICATION

A. Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for equipment labels and warning signs and labels.

3.5 FIELD QUALITY CONTROL

A. **Testing Agency**: **Owner will engage** a qualified testing agency to perform tests and inspections.

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 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.

D. Tests and Inspections:

1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
2. Leak Test: After installation, fill water coils 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.

E. Air terminal unit will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

G. Cleaning:
1. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes.

3.6 STARTUP SERVICE

A. **Engage a factory-authorized service representative to perform** startup service.

1. Complete installation and startup checks according to:
   a. Manufacturer's written instructions.
   b. Construction documents.
2. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
3. Verify that controls and control enclosure are accessible.
4. Verify that control connections are complete.
5. Verify that nameplate and identification tag are visible.
6. Verify that controls respond to inputs as specified.

3.7 DEMONSTRATION

A. **Engage a factory-authorized service representative to train** Owner's maintenance personnel to adjust, operate, and maintain air terminal units:

1. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.
2. Review data in the maintenance manuals. Refer to Division 1 Section "Contract Closeout."
3. Review data in the maintenance manuals. Refer to Division 1 Section "Operation and Maintenance Data."
4. Schedule training with Owner, through Architect, with at least 7 days' advance notice.

END OF SECTION 233600

SECTION 233713 - DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This section includes ceiling- and wall-mounted diffusers, registers, and grilles.

B. Related Sections:

1. Section 233714 "Fixed Louvers" for fixed and louvers and wall vents, whether or not they are connected to ducts.
2. Section 233300 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.
3. Section 230594 "General Testing, Adjusting and Balancing" for balancing diffusers, registers, and grilles.

1.3 ACTION 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.

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. Size and location of initial access modules for acoustical tile.
4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
5. Duct access panels.

B. Source quality-control reports.

1.5 QUALITY ASSURANCE

A. Product Options: Drawings and schedules indicate specific requirements of diffusers, registers, and grilles and are based on the specific requirements of the systems indicated.

B. NFPA Compliance: Install diffusers, registers, and grilles according to NFPA 90A, "Standard for the Installation of Air-Conditioning and Ventilating Systems."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Air Factors
2. Carnes.
3. METALAIRE, Inc.
4. Nailor Industries Inc.
5. Price Industries.
6. Titus.
7. Tuttle & Bailey.

2.2 REGISTERS, GRILLES, & DIFFUSERS

A. General: The frames for all registers, grilles, and diffusers shall match type of ceiling where they are to be installed. Special frames shall be provided for narrow T-bar ceilings. Refer to reflected ceiling plan and other specification divisions for ceiling type. See drawings AND schedules for additional information.

2.3 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

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

3.2 INSTALLATION

A. Install diffusers, registers, and grilles level and plumb, according to manufacturer's written instructions, coordination drawings, original design, and referenced standards.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as 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.

3.4 CLEANING

A. After installation of diffusers, registers, and grilles, inspect exposed finish. Clean exposed surfaces to remove burrs, dirt, and smudges. Replace diffusers, registers, and grilles that have damaged finishes.

END OF SECTION 233713

SECTION 233714 - FIXED LOUVERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Fixed, extruded-aluminum louvers.

B. Related Requirements:

1. Section 099113 "Exterior Painting" for field painting louvers.

1.3 DEFINITIONS

A. Louver Terminology: Definitions of terms for metal louvers contained in AMCA 501 apply to this Section unless otherwise defined in this Section or in referenced standards.

B. Horizontal Louver: Louver with horizontal blades (i.e., the axes of the blades are horizontal).

C. Vertical Louver: Louver with vertical blades (i.e., the axes of the blades are vertical).

D. Drainable-Blade Louver: Louver with blades having gutters that collect water and drain it to channels in jambs and mullions, which carry it to bottom of unit and away from opening.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. For louvers specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.

B. Shop Drawings: For louvers and accessories. Include plans, elevations, sections, details, and attachments to other work. Show frame profiles and blade profiles, angles, and spacing.

1. Show weep paths, gaskets, flashing, sealant, and other means of preventing water intrusion.

2. Show mullion profiles and locations.

C. Samples: For each type of metal finish required.

1.5 INFORMATIONAL SUBMITTALS

A. Product Test Reports: Based on evaluation of comprehensive tests performed according to AMCA 500-L by a qualified testing agency or by manufacturer and witnessed by a qualified testing agency, for each type of louver and showing compliance with performance requirements specified.

1.6 QUALITY ASSURANCE

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

1. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."

1.7 FIELD CONDITIONS

A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain louvers from single source from a single manufacturer where indicated to be of same type, design, or factory-applied color finish.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Louvers, including attachments to other construction, shall withstand the effects of earthquake motions determined according to [ASCE/SEI 7].

1. Design Spectral Response Acceleration at Short Periods: Per the structural drawings and specifications.
2. Component Importance Factor: [1.5] [1.0].

B. Louver Performance Ratings: Provide louvers complying with requirements specified, as demonstrated by testing manufacturer's stock units identical to those provided, except for length and width according to AMCA 500-L.

C. SMACNA Standard: Comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" for fabrication, construction details, and installation procedures.

2.3 FIXED, EXTRUDED-ALUMINUM LOUVERS

A. Horizontal, Drainable-Blade Louver :

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Airolite Company, LLC (The).
   b. Pottorff.
   c. Greenheck Fan Corporation.

2. Louver Performance Ratings:

   a. Free Area: Not less than 8.5 sq. ft. for 48-inch- wide by 48-inch- high louver.
   b. Point of Beginning Water Penetration: Not less than 1250 fpm.
   c. Air Performance – intake: Not more than 0.10-inch wg static pressure drop at 900-fpm free-area velocity.
   d. Air Performance – exhaust: Not more than 0.15-inch wg static pressure drop at 1000-fpm free-area velocity.

3. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

2.4 LOUVER SCREENS

A. General: Provide screen at each exterior louver.

1. Screen Location for Fixed Louvers: Interior face.
2. Screening Type: Bird screening.

B. Secure screen frames to louver frames with machine screws with heads finished to match louver, spaced a maximum of 6 inches from each corner and at 12 inches o.c.

C. Louver Screen Frames: Fabricate with mitered corners to louver sizes indicated.

1. Metal: Same type and form of metal as indicated for louver to which screens are attached. Reinforce extruded-aluminum screen frames at corners with clips.
2. Finish: Same finish as louver frames to which louver screens are attached.
3. Type: Rewirable frames with a driven spline or insert

D. Louver Screening for Aluminum Louvers:

2.5 BLANK-OFF PANELS

A. Uninsulated, Blank-Off Panels: Metal sheet attached to back of louver.

1. Aluminum sheet for aluminum louvers, not less than 0.050-inch nominal thickness.
2. Galvanized-steel sheet for galvanized-steel louvers, not less than [0.040-inch] [0.052-inch] nominal thickness.
3. Stainless-steel sheet for stainless-steel louvers, not less than [0.038-inch] [0.050-inch] nominal thickness, with grain running in same direction as grain of louver blades.
4. Panel Finish: [Same finish applied to louvers] [Same finish type applied to louvers, but black color].
5. Attach blank-off panels with [clips] [sheet metal screws].

B. Insulated, Blank-Off Panels: Laminated panels consisting of an insulating core surfaced on back and front with metal sheets and attached to back of louver.

1. Thickness: [1 inch] [2 inches].
2. Metal Facing Sheets: Aluminum sheet, not less than 0.032-inch nominal thickness.
3. Metal Facing Sheets: Galvanized-steel sheet, not less than 0.028-inch nominal thickness.
4. Metal Facing Sheets: Stainless-steel sheet, not less than 0.031-inch nominal thickness.
5. Insulating Core: [Rigid, glass-fiber-board insulation] [extruded-polystyrene foam].
6. Edge Treatment: Trim perimeter edges of blank-off panels with louver manufacturer's standard [extruded-aluminum-channel frames, not less than 0.080-inchnominal thickness] [channel frames], with corners mitered and with same finish as panels.
7. Seal perimeter joints between panel faces and louver frames with gaskets or sealant.
8. Panel Finish: [Same finish applied to louvers] [Same type of finish applied to louvers, but black color].
9. Attach blank-off panels with [clips] [sheet metal screws].

2.6 MATERIALS

A. Aluminum Extrusions: ASTM B 221, Alloy 6063-T5, T-52, or T6.

B. Aluminum Sheet: ASTM B 209, Alloy 3003 or 5005 with temper as required for forming, or as otherwise recommended by metal producer for required finish.

C. Fasteners: Use types and sizes to suit unit installation conditions.
1. Contractor shall use or hex-head or screws for exposed fasteners screws for exposed fasteners unless otherwise indicated.
2. For fastening aluminum, use aluminum or 300 series stainless-steel fasteners.
3. For color-finished louvers, use fasteners with heads that match color of louvers.

D. Postinstalled Fasteners for Concrete and Masonry: Torque-controlled expansion anchors, made from stainless-steel components, with capability to sustain, without failure, a load equal to 4 times the loads imposed, for concrete, or 6 times the load imposed for masonry, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.

E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.7 FABRICATION

A. Factory assemble louvers to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

B. Maintain equal louver blade spacing, including separation between blades and frames at head and sill, to produce uniform appearance.

C. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.

1. Frame Type: Channel unless otherwise indicated.

D. Include supports, anchorages, and accessories required for complete assembly.

E. Join frame members to each other and to fixed louver blades with fillet welds concealed from view unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.

2.8 ALUMINUM FINISHES

A. Finish louvers after assembly.

B. Color Anodic Finish: AAMA 611, or thicker.
1. Color: As selected by Architect from full range of industry colors and color densities.

C. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1. Color and Gloss: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and openings, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

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

3.2 PREPARATION

A. Coordinate setting drawings, diagrams, templates, instructions, and directions for installation of anchorages that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

3.3 INSTALLATION

A. Locate and place louvers level, plumb, and at indicated alignment with adjacent work.

B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weather-tight connection.

C. Form closely fitted joints with exposed connections accurately located and secured.

D. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.

E. Protect unpainted galvanized and nonferrous-metal surfaces that are in contact with concrete, masonry, or dissimilar metals from corrosion and galvanic action by applying a heavy coating of bituminous paint or by separating surfaces with waterproof gaskets or nonmetallic flashing.

F. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weather-tight louver joints are required. Comply with Section 079200 "Joint Sealants" for sealants applied during louver installation.

3.4 ADJUSTING AND CLEANING

A. Clean exposed louver surfaces that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate during construction period.

B. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.

C. Restore louvers damaged during installation and construction so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.

1. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

END OF SECTION 233714

SECTION 235100 - BREECHINGS, CHIMNEYS, AND STACKS

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. CATEGORY IV, CONDENSING BOILERS, SPECIAL GAS VENTS
   a. Listed:
      1) Double-wall vents.
   b. This section specifies:
      1) Category IV vents/chimneys.
      2) Special Gas Units.
      3) Condensing Boilers – positive pressure.

B. Related Sections include the following:

1. Section 235113 "Draft Control Devices" for induced-draft and mechanical fans and for motorized and barometric dampers.

1.3 ACTION SUBMITTALS

A. Product Data: For the following:

1. Chimney liners.
2. Type B and BW vents.
3. Type L vents.
4. Special gas vents. (Category IV, Condensing Boilers, Special Gas Vents).
5. Building-heating-appliance chimneys. (Forced Draft Boilers) .
6. Grease ducts.
7. Refractory-lined metal breechings and chimneys.
8. Guy wires and connectors.

B. Shop Drawings: For vents, breechings, chimneys, and stacks. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, methods of field assembly, components, hangers and seismic restraints, and location and size of each field connection.
2. For installed products indicated to comply with design loads, include calculations required for selecting seismic restraints and structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Manufacturer Seismic Qualification Certification: Submit certification that factory-fabricated breeching, chimneys, and stacks; accessories; and components will withstand seismic forces defined in Section 230548 "Vibration and Seismic Controls for HVAC." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

   a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
   b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Breeching, Chimneys, and Stacks: Identify center of gravity and locate and describe mounting and anchorage provisions.

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

C. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain listed system components through one source from a single manufacturer.

B. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code--Steel," for hangers and supports and AWS D9.1/D9.1M, "Sheet Metal Welding Code," for shop and field welding of joints and seams in vents, breechings, and stacks.

C. Certified Sizing Calculations: Manufacturer shall certify venting system sizing calculations.

D. Verification: Flue type to be verified by the boiler manufacturer of the submitted boiler.

1.6 COORDINATION

A. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of venting system that fail in materials or workmanship within specified warranty period. Failures include, but are not limited to, structural failures caused by expansion and contraction.

1. Warranty Period: To cover the following number of years from date of Substantial Completion:
   a. 10 years.

PART 2 - PRODUCTS

2.1 LISTED SPECIAL GAS VENTS (POSITIVE PRESSURE FLUES)

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. Heat-Fab, Inc.
2. Z-Flex; a division of the Novaflex Group.
3. Metal-Fab, Inc.

B. Description: Double-wall metal vents tested according to UL 1738 and rated for 480 deg F continuously, with positive or negative flue pressure complying with NFPA 211.

C. Construction: Inner shell and outer jacket separated by at least a 1/2-inch airspace.

D. Inner Shell: ASTM A 959, Type 29-4C stainless steel.

E. Outer Jacket:
1. Aluminized steel.
2. Grade 430 Stainless steel.

F. Accessories: Tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.

1. Termination: Stack cap designed to exclude minimum 90 percent of rainfall.
2. Termination: Round chimney top designed to exclude minimum 98 percent of rainfall.
3. Termination: Exit cone with drain section incorporated into riser.

2.2 GUYING AND BRACING MATERIALS

A. Cable: Three galvanized, stranded wires of the following thickness:

1. Minimum Size: 1/4 inch in diameter.
2. For ID Sizes 4 to 15 Inches: 5/16 inch.
3. For ID Sizes 18 to 24 Inches: 3/8 inch.
4. For ID Sizes 27 to 30 Inches: 7/16 inch.
5. For ID Sizes 33 to 36 Inches: 1/2 inch.
6. For ID Sizes 39 to 48 Inches: 9/16 inch.
7. For ID Sizes 51 to 60 Inches: 5/8 inch.

B. Pipe: Two galvanized steel, NPS 1-1/4.

C. Angle Iron: Two galvanized steel, 2 by 2 by 0.25 inch.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of work.

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

3.2 APPLICATION

A. Listed Type B and BW Vents: Vents for certified gas appliances.

B. Listed Special Gas Vent: Condensing gas appliances.

C. Listed Building-Heating-Appliance Chimneys: Dual-fuel boilers, oven vents, water heaters, and exhaust for engines. Fireplaces and other solid-fuel-burning appliances.

D. Field-Fabricated Metal Breechings and Chimneys: Dual-fuel boilers, oven vents, water heaters, exhaust for engines, fireplaces, and other solid-fuel-burning appliances.

E. Field-Fabricated Metal Breechings and Chimneys: Steel pipe for use with engine exhaust.

3.3 INSTALLATION OF LISTED VENTS AND CHIMNEYS

A. Locate to comply with minimum clearances from combustibles and minimum termination heights according to product listing or NFPA 211, whichever is most stringent.

B. Seal between sections of positive-pressure vents and grease exhaust ducts according to manufacturer's written installation instructions, using sealants recommended by manufacturer.

C. Support vents at intervals recommended by manufacturer to support weight of vents and all accessories, without exceeding appliance loading.

D. Slope breechings down in direction of appliance, with condensate drain connection at lowest point piped to nearest drain.

E. Lap joints in direction of flow.

3.4 INSTALLATION OF UNLISTED, FIELD-FABRICATED BREECHINGS AND CHIMNEYS

A. Suspend breechings and chimneys independent of their appliance connections.

B. Install, support, and restrain according to seismic requirements.

C. Align breechings at connections, with smooth internal surface and a maximum 1/8-inch misalignment tolerance.

D. Slope breechings down in direction of appliance, with condensate drain connection at lowest point piped to nearest drain.

E. Lap joints in direction of flow.

F. Support breechings and chimneys from building structure with bolts, concrete inserts, steel expansion anchors, welded studs, C-clamps, or beam clamps according to manufacturer's written instructions.

3.5 CLEANING

A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.

B. Clean breechings internally, during and after installation, to remove dust and debris. Clean external surfaces to remove welding slag and mill film. Grind welds smooth and apply touchup finish to match factory or shop finish.

C. Provide temporary closures at ends of breechings, chimneys, and stacks that are not completed or connected to equipment.

END OF SECTION 235100

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SECTION 235216 - CONDENSING BOILERS

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, factory-fabricated and -assembled, gas-fired, fire-tube condensing boilers, trim, and accessories for generating hot water. Provide integral pump.

B. This Division shall arrange and pay to have the State of Utah inspect the Boilers for operation.

C. Provide factory controls.

D. The Boiler manufacturer is to supply a remote temperature setpoint ability via a 4-20 MA signal from the Building Management system.

E. The Boiler shall come with all controls to operate and tie into the building controls.

F. Provide a boiler room kill switch and interlock with the building and boiler controls.

G. This Division shall arrange and pay to have the State of Utah inspect the Boilers for operation.

H. The Boiler manufacturer shall supply as part of the boiler package a completely integrated boiler management system (equal to Aerco Model 168). Programmer to control all operation and energy input of the boiler plant. The boiler management system shall be comprised of a microprocessor based control utilizing MODBUS protocol to communicate with the boilers via the RS-485 port. The boiler management panel is to ship loose for mounting by this contractor and control wiring performed by temperature control contractor. Control contractor to supply 4-20 MA signal to BMS panel. Control contractor to wire between the BMS and boilers per manufacturers instructions.

1.3 SUBMITTALS

A. Product Data: Include performance data, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: For boilers, boiler trim, and accessories. Include plans, elevations, sections, details, and attachments to other work.

1. Design calculations and vibration isolation base details, signed and sealed by a qualified professional engineer.

    a. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
    b. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails and equipment mounting frames.

2. Wiring Diagrams: Power, signal, and control wiring.

C. Manufacturer Seismic Qualification Certification: Submit certification that boiler, accessories, and components will withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment." 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. Source quality-control test reports.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For boilers to include in emergency, operation, and maintenance manuals.

G. Warranty: Special warranty specified in this Section.

H. Other Informational Submittals:

1. ASME Stamp Certification and Report: Submit "A," "S," or "PP" stamp certificate of authorization, as required by authorities having jurisdiction, and document hydrostatic testing of piping external to boiler.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.

C. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."

D. DOE Compliance: Minimum efficiency shall comply with 10 CFR 430, Subpart B, Appendix N, "Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers."

E. UL Compliance: Test boilers for compliance with UL 795, "Commercial-Industrial Gas Heating Equipment." Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

1.5 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.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Fire-Tube Condensing Boilers:

a. Leakage and Materials: 10 years from date of Substantial Completion.
b. Heat Exchanger Damaged by Thermal Stress and Corrosion: Nonprorated for five years from date of Substantial Completion.

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. AERCO International.
2. Cleaver Brooks.
3. Hamilton Engineering – EVO.
4. Viessmann.

5. Patterson Kelly PK

2.2 MANUFACTURED UNITS

A. Description: Factory-fabricated, -assembled, and -tested, fire-tube condensing boiler with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls. Water heating service only.

B. Heat Exchanger: Nonferrous, corrosion-resistant combustion chamber.

C. Pressure Vessel: Carbon steel with welded heads and tube connections.

D. Burner: Natural gas, forced draft.

E. Blower: Centrifugal fan to operate during each burner firing sequence and to prepurge and postpurge the combustion chamber.

1. Motors: Comply with requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

a. 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.

F. Gas Train: Combination gas valve with manual shutoff and pressure regulator.

G. Ignition: Spark ignition with 100 percent main-valve shutoff with electronic flame supervision.

H. Casing:

1. Jacket: Sheet metal, with snap-in or interlocking closures.
2. Control Compartment Enclosures: NEMA 250, Type 1A.
3. Finish: Powder-coated protective finish.
4. Insulation: Minimum 2-inch- (50-mm-) thick, polyurethane-foam insulation surrounding the heat exchanger.
5. Combustion-Air Connections: Inlet and vent duct collars.
6. Mounting base to secure boiler.

a. Seismic Fabrication Requirements: Fabricate mounting base and attachment to boiler pressure vessel, accessories, and components with reinforcement strong enough to withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" when mounting base is anchored to building structure.

2.3 TRIM

A. Include devices sized to comply with ANSI B31.1, "Power Piping."

B. Aquastat Controllers: Operating, firing rate, and high limit.

C. Safety Relief Valve: ASME rated.

D. Pressure and Temperature Gage: Minimum 3-1/2-inch- (89-mm-) diameter, combination water-pressure and -temperature gage. Gages shall have operating-pressure and -temperature ranges so normal operating range is about 50 percent of full range.

E. Boiler Air Vent: Automatic.

F. Drain Valve: Minimum NPS 3/4 (DN 20) hose-end gate valve.

G. Circulation Pump: Non-overloading, in-line pump with split-capacitor motor having thermal-overload protection and lubricated bearings; designed to operate at specified boiler pressures and temperatures.

2.4 CONTROLS

A. Refer to Section "Instrumentation and Control for HVAC."

B. Building Management System Interface: Factory install hardware and software to enable building management system to monitor, control, and display boiler status and alarms.

1. Hardwired Points:

   a. Monitoring: On/off status, common trouble alarm low water level alarm.
   b. Control: On/off operation, hot water supply temperature set-point adjustment.

2. A communication interface with building management system shall enable building management system operator to remotely control and monitor the boiler from an operator workstation. Control features available, and monitoring points displayed, locally at boiler control panel shall be available through building management system.

2.5 ELECTRICAL POWER

A. Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.

1. House in NEMA 250, Type 1 enclosure.
2. Wiring shall be numbered and color-coded to match wiring diagram.
3. Install factory wiring outside of an enclosure in a metal raceway.
4. Field power interface shall be to fused disconnect switch.
5. Provide branch power circuit to each motor and to controls with a disconnect switch or circuit breaker.

6. Provide each motor with overcurrent protection.

2.6 VENTING KITS

A. Kit: Complete system, ASTM A 959, Type 29-4C stainless steel, pipe, vent terminal, thimble, indoor plate, vent adapter, condensate trap and dilution tank, and sealant.

B. Combustion-Air Intake: Complete system, stainless steel, pipe, vent terminal with screen, inlet air coupling, and sealant.

2.7 SOURCE QUALITY CONTROL

A. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.

B. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.

C. Allow Owner access to source quality-control testing of boilers. Notify Architect 14 days in advance of testing.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Before boiler installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting boiler performance, maintenance, and operations.

1. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.

B. Examine mechanical spaces for suitable conditions where boilers will be installed.

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

3.2 BOILER INSTALLATION

A. Install boilers level on concrete base. Concrete base is specified in Division 23 Section "Common Work Results for HVAC," and concrete materials and installation requirements are specified in Division 03.

B. Vibration Isolation: Elastomeric isolation pads with a minimum static deflection of 0.25 inch. Vibration isolation devices and installation requirements are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

C. Install gas-fired boilers according to NFPA 54.

D. Assemble and install boiler trim.

E. Install electrical devices furnished with boiler but not specified to be factory mounted.

F. Install control wiring to field-mounted electrical devices.

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 boiler to allow service and maintenance.

C. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.

D. Connect piping to boilers, except safety relief valve connections, with flexible connectors of materials suitable for service. Flexible connectors and their installation are specified in Division 23 Section "Common Work Results for HVAC."

E. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas train connection. Provide a reducer if required.

F. Connect hot-water piping to supply- and return-boiler tappings with shutoff valve and union or flange at each connection.

G. Install piping from safety relief valves to nearest floor drain.

H. Boiler Venting:

1. Install flue venting kit and combustion-air intake.
2. Connect full size to boiler connections.

I. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

J. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Perform installation and startup checks according to manufacturer's written instructions.
2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

    a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level and steam pressure.
    b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Remove and replace malfunctioning units and retest as specified above.

D. Performance Tests:

1. Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.
2. Boilers shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment to comply.
3. Perform field performance tests to determine capacity and efficiency of boilers.

    a. Test for full capacity.

4. Repeat tests until results comply with requirements indicated.
5. Provide analysis equipment required to determine performance.
6. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are not adequate.
7. Notify Architect in advance of test dates.
8. Document test results in a report and submit to Architect.

END OF SECTION 235216

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 **shell-and-tube** heat exchangers for steam to water conversion.

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. Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.

1.5 INFORMATIONAL SUBMITTALS

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

1. Tube-removal space.
2. Structural members to which heat exchangers will be attached.

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's standard form in which manufacturer agrees to repair or replace components of domestic-water 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. Shell-and-Tube, Domestic-Water Heat Exchangers:

1) Tube Coil: **One** year.
2) Other Components: **One** year.

b. Plate, Domestic-Water Heat Exchangers:

1) Brazed-Plate Type: **One** year.
2) Plate-and-Frame Type: **One** year.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified."

2.2 SHELL-AND-TUBE HEAT EXCHANGERS

A. Retain "Manufacturers" Paragraph and list of manufacturers below to require products from manufacturers listed or a comparable product from other manufacturers.

B. Products: Subject to compliance with requirements, provide one of the following:
   1. Dunham-Bush, Inc.
   2. ITT Corporation.
   3. Patterson_Kelley Co.; Division of Harsco Corp.
   4. TACO Incorporated.
   5. Thrush Co. Inc.

C. Description: Packaged assembly of tank, heat-exchanger coils, and specialties.

D. Construction:

   1. Fabricate and label heat exchangers to comply with ASME Boiler and Pressure Vessel Code, Section VIII, "Pressure Vessels," Division 1.
   2. Fabricate and label shell-and-tube heat exchangers to comply with "TEMA Standards."

E. Configuration:
   1. **U-tube with removable** bundle.

F. Shell Materials: **Steel.**

G. Head:

   1. Materials:
      a. Cast iron
   2. Flanged and bolted to shell.

H. Tube:

   1. **Seamless copper** tubes.
   2. Tube diameter is determined by manufacturer based on service.

I. Tubesheet Materials: **Steel.**

J. Baffles: **Steel.**

K. 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 according to ASME B1.20.1.
   2. **NPS 2-1/2** and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.

L. Support Saddles:

   1. Fabricated of material similar to shell.
   2. Fabricate foot mount with provision for anchoring to support.

3. Fabricate attachment of saddle supports to pressure vessel with reinforcement strong enough to resist heat-exchanger movement during seismic event when heat-exchanger saddles are anchored to building structure.

M. Capacities and Characteristics: (See Drawing Schedules).

1. Shell Side:

a. Fluid: **Steam**.

2. Tube Side:

a. Fluid: **Water**.

2.3 ACCESSORIES

A. Hangers and Supports:

1. Custom, steel **supports** for mounting on:
a. Floor.

2. Ensure both horizontal and vertical support of heat exchanger by providing:
a. **Factory-**fabricated steel **supports**.

3. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Shroud:
1. **Steel** sheet.

C. Miscellaneous Components for High-Temperature Hot-Water Unit: Control valve, valves, and piping.

D. Miscellaneous Components for Steam Unit: Strainers, steam-control valve, steam trap, valves, pressure gage, thermometer, and piping.

E. Pressure Relief Valves:
1. Cast iron
2. ASME rated and stamped.

2.4 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect heat exchangers according to ASME Boiler and Pressure Vessel Code, Section VIII, "Pressure Vessels," Division 1. Affix ASME 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 SHELL-AND-TUBE HEAT-EXCHANGER INSTALLATION

A. Equipment Mounting:

1. Install heat exchangers on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in **Division 03**.
2. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

B. Install heat exchangers on saddle supports.

C. Heat-Exchanger Supports: Use factory-fabricated steel cradles and supports specifically designed for each heat exchanger.

3.3 CONNECTIONS

A. Comply with requirements for piping specified in other;
1. Section 232113 "Hydronic Piping."
2. Section 232116 “Hydronic Piping Specialties."
3. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Comply with requirements for steam and condensate piping specified in:
1. Section 232213 "Steam and Condensate Heating Piping"
2. Section 232216 “Steam and Condensate Piping Specialties."

C. Maintain manufacturer's recommended clearances for tube removal, service, and maintenance.

D. Install piping adjacent to heat exchangers to allow space for service and maintenance of heat exchangers. Arrange piping for easy removal of heat exchangers.

E. Install shutoff valves at heat-exchanger inlet and outlet connections.

F. Install relief valves on heat-exchanger heated-fluid connection and install pipe relief valves, full size of valve connection, to floor drain.

G. Install vacuum breaker at heat-exchanger steam inlet connection.

H. Install hose end valve to drain shell.

I. Install thermometer on heat-exchanger **and outlet** piping, and install thermometer on heating-fluid **outlet** piping.

J. Comply with requirements for thermometers specified in Section 230519 "Meters and Gages for HVAC Piping."

K. Install pressure gages on heat-exchanger and heating-fluid piping. Comply with requirements for pressure gages specified in Section 230519 "Meters and Gages for HVAC Piping."

3.4 FIELD QUALITY CONTROL

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

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.

B. Heat exchanger will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

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.

3.6 DEMONSTRATION

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

END OF SECTION 235700

SECTION 237326 - CUSTOM 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 custom air-handling units for indoor installations.
1. Factory-fabricated, field-assembled, double-wall casings for HVAC equipment
2. Shop Drawings for each air handler are required.
3. This division shall be responsible for complete submittals which shall include the engineering of the Casings, filters, coils. Dampers and fans. The Air Handlers shall be engineering and submitted with shop drawings.
4. Air handlers shall be provided with a multi-fan matrix (minimum number fans scheduled). The multiple fans must comply with the manufactures recommendations distances for space before, after and to the sides of each fan.
5. Each fan matrix shall be wired for a single point connection.

1.3 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.

B. Product Data for each central-station air-handling unit specified, including the following:
1. Certified fan-performance curves with system operating conditions indicated.
2. Certified fan-sound power ratings.
3. Certified coil-performance ratings with system operating conditions indicated.
4. Motor ratings and electrical characteristics plus motor and fan accessories.
5. Material gages and finishes.
6. Filters with performance characteristics.
7. Dampers, including housings, linkages, and operators.

C. Shop Drawings from manufacturer detailing equipment assemblies and indicating dimensions, weights, loadings, required clearances, method of field assembly, components, and location and size of each field connection.

D. Coordination Drawings, including floor plans and sections drawn to scale. Submit with Shop Drawings. Show mechanical-room layout and relationships between components and adjacent

structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.

E. Field test reports indicating and interpreting test results relative to compliance with specified requirements.

F. Maintenance data for custom air-handling units to include in the operation and maintenance manual.

1.4 QUALITY ASSURANCE

A. UL and NEMA Compliance: Provide motors required as part of air-handling units that are listed and labeled by UL and comply with applicable NEMA standards.

B. Comply with NFPA 70 for components.

C. Listing and Labeling: Provide electrically operated components specified in this Section that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.
2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

D. Coordination: Coordinate layout and installation of air-handling units with piping and ductwork and with other installations.

E. Air Handling units and major components shall be products of Manufacturing firms regularly engaged in manufacture of this equipment with characteristics and capacities required and whose products have been in satisfactory use in similar service.

F. A factory witness test of the first and last air handler shall accommodate a pressure test, and signed by both the manufacturer and the mechanical engineer.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver air-handling unit as a factory-assembled module with protective crating and covering.

B. Lift and support units with manufacturer's designated lifting or supporting points.

C. Field assembled units furnished in multiple sections per manufacturers instructions.

1.6 SEQUENCING AND SCHEDULING

A. Coordinate size and location of concrete housekeeping bases. Cast anchor-bolt inserts into base.

B. Coordinate size and location of structural-steel support members.

1.7 EXTRA MATERIALS

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

B. Filters: Furnish 1 set for each air-handling unit.

1.8 WARRANTY

A. The special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of Contract Documents.

B. Special Warranty: Submit a written warranty signed by manufacturer and Installer agreeing to repair any leaks in the exterior units casings for a period 5 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance by one of the following:

1. Climate Craft
2. Haakon
3. Huntair
4. Temtrol
5. Unitech

2.2 MANUFACTURED UNITS

A. General Description: Factory assembled, consisting of fans, motor and drive assembly, coils, damper, plenums, filters, drip pans, and mixing dampers.

B. Motor and Electrical Components: Refer to Division 23 Section "Motors."

2.3 CASING

A. Walls and roof shall be constructed of 16 gauge powder coated steel 4-inch minimum thick acoustic thermal panels or thicker as required to meet sound performance and maximum deflection criteria. The inner liner shall be 22 gauge perforated galvanized steel. Insulation shall be 4 lb. density mineral wool. All panel seams shall be sealed during assembly to produce an airtight unit. 3 inch or 2 inch walls or doors is not acceptable. 7,000 hour salt spray powder coat finish for both interior an exterior walls and roof on both indoor and outdoor air handlers.

B. All insulation edges shall be protected with metal lagging. Insulation systems using stickpin or adhesives are not acceptable. Insulation shall be 2” thick, 4 lbs per cubic foot density, mineral wool to cover all walls and ceilings. 2” thick (minimum) spray polyurethane foam shall be used under floors. Insulation shall meet NFPA-90A smoke and flame spread requirements. There shall be no raw edges of insulation exposed to the airstream.

C. The floor shall be supported by structural and minimum 12-gauge formed galvanized steel members.

D. Drain Pans: Continuously welded 304 stainless steel. Fabricate pans in sizes and shapes to collect condensate from cooling coils (including coil piping connections and return bends) when units are operating at maximum catalogued face velocity across cooling coil.

1. Double-Wall Construction: Fill space between walls with foam insulation and seal moisture tight.
2. Drain Connections: At coil piping side of unit.
3. Units with stacked coils shall have an intermediate drain pan or drain trough to collect condensate from top coil.

2.4 BASE CONSTRUCTION

A. Units shall be constructed from structural steel C-channel iron around the perimeter of the unit or each section, with intermediate channel and angle supports. Units less than or equal to 20' long shall have a minimum of 4" channel, and units greater than 20' shall have a minimum 6" channel.

B. 12 gauge checker plate floor shall be installed on the base. Floor shall be flat reinforced from below, with all seams continuously welded. Base shall be provided with lifting lugs, minimum four (4) per unit section. The base shall be insulated with 2” spray polyurethane foam insulation and sheeted with a 22 gauge galvanized steel liner. Floors that oil can are not acceptable.

C. Provide a 1.5" perimeter collar around the entire unit, and around each floor opening to ensure the unit is internally watertight. The entire base shall act as an auxiliary drain pan and hold up to 1.5" of water.

D. Provide auxiliary drains in fan sections downstream of cooling coils, and in mixing sections.

E. All drain connections on floor mounted air handling units shall terminate at coil connection side of the unit.

2.5 ACCESS DOORS

A. Access doors shall be manufactured from 16 gauge galvanized steel. The doors shall be double wall construction with 22 gauge solid metal liner on the inside. Corners of the doors shall be continuously welded for rigidity. Two inch 3 lb/cu ft density insulation shall be sandwiched between the 16 gauge outer layer and the 22 gauge inner layer. Doors MUST be the same thickness as the unit casing to maximize thermal and acoustical resistance. A 12" square or round HERMETICALLY SEALED Double Glazed Laminated glass window shall be provided in each door. Hinges shall be continuous piano type stainless steel. Provide a Hinged access door to access all components, including doors between all coils.

B. Two (2) Ventlock Model #310 high pressure latches operable from either side of the door shall be provided. Door opening shall be fully gasketed with continuous 1/2" closed cell hollow round black gasket with a metal encapsulated reinforcing backing that mechanically fastens to the door frame. Door frames shall be made from 16 gauge galvanized steel with the outside size of the door flush with the unit. Minimum door opening size shall be 18" x 70" (where height permits). Fan compartments must have a door of minimum width to remove the motor.

C. All access doors must swing against the air pressure (i.e. positive pressure plenum doors must swing in).

2.6 PIPING

A. Condensate Drain Lines: Type L drawn-temper copper tubing with soldered joints. Pipe to the outside of the unit.

2.7 MULTIPLE FAN ARRANGEMENTS

A. The Air Handler shall consists of multiple direct driven plenum fans constructed per AMCA requirements for the duty specified operating Total Static Pressure and specified fan/motor speed. The entire fan array shall be AMCA certified, AMCA certification of individual fans is not acceptable. The Fans shall be selected to operate at a system Total Static Pressure that does not exceed 90% of the specified fan’s peak static pressure producing capability at the specified fan/motor speed. All motors shall include isolated bearings or shaft grounding. Each unit shall be provided with a blank off plate.

B. The fans shall consist of multiple fans and motors spaced in the air way tunnel cross section to provide a uniform air flow and velocity profile across the entire air way tunnel cross section and components contained therein. Each fan shall be individually wired to a control panel.. Wire

C. See drawings for sound requirements.

2.8 MOTORS AND DRIVES

A. General: Refer to Division 23 Section "Motors" for general requirements.

2.9 COILS

A. Fins shall have collars drawn, belled and firmly bonded to the tubes by means of mechanical expansion of the tubes. No soldering or tinning shall be used in the bonding process. Coils shall be mounted in the unit casing to be accessible for service. Capacities, pressure drops and selection procedure shall be certified in accordance with ARI Standard 410.

B. Coils shall be fully enclosed within the casing and cooling coils shall be on mounted 304 stainless steel angle racks manufactured to allow coils to slide out individually. Heating coils shall be mounted on galvanized angle racks manufactured to allow coils to slide out individually.

C. Removable coil access panels shall be provided for removal of coils through the casing wall. Coils shall be individually removable towards the access side. Coils must be individually racked, removable through the side access panels.

D. The manufacturer shall provide drain pans for all cooling coils. Drain pans shall be continuously welded 304 stainless steel. The coil section must have intermediate drain pans and shall be interconnected with 1” stainless steel drain lines. Drain pans shall be IAQ sloped and fully drainable.

E. Coils shall be fully drainable by removing a single threaded plug for each coil row.

F. All pipe connections shall be on the same unit end, extended through the casing for ease of connection.

G. Water coils handling recently mixed air, or direct outside air, shall be fully drainable by removing a single threaded plug for each coil row.

H. The primary surface shall be round seamless 5/8” .020 O.D copper tube on 1½” centers, staggered in the direction of airflow. All joints shall be brazed.

I. The secondary surface shall consist of rippled aluminum plate fins for higher capacity and structural strength. Fins shall have full drawn collars to provide a continuous surface cover over the entire tube for maximum heat transfer. Bare copper tube shall not be visible between fins and the fins shall have no openings or holes which might accumulate lint and dirt. Tubes shall

be mechanically expanded into the fins to provide a continuous primary to secondary compression bond over the entire finned length for maximum heat transfer rates.

J. The casings shall be constructed of continuous galvanized steel. Coil side plates shall be of reinforced flange type.

K. The coil connection locations shall permit universal mounting of the coil for right or left hand airflow and have equal pressure drop through all circuits. Coils shall be circuited for counterflow heat transfer to provide the maximum mean effective temperature difference for maximum heat transfer rates.

L. Headers on water coils shall be seamless copper tubing. The headers shall have intruded tube holes to provide a large brazing surface for maximum strength and inherent flexibility.

M. The complete coil core shall be tested with 315 pounds air pressure under warm water and be suitable for operation at 250 psig working pressures. Individual tube and core tests before installation of headers is not considered satisfactory. Hydrostatic tests alone will not be acceptable. Water cooling coils shall be circuited for drainability.

N. Mixing dampers shall be parallel blades directed toward each other to promote good mixing.

2.10 AIR FOIL DAMPERS

A. General: Leakage rate, according to AMCA 500, "Test Methods for Louvers, Dampers and Shutters," shall not exceed 2 percent of air quantity at 2000-fpm face velocity through damper and 4-inch wg pressure differential.
   1. Damper operators are specified in Division 23.

B. Dampers shall be as follows:

   1. Aluminum airfoil frames and blades shall be a minimum of 12 gauge (.081”) extruded aluminum. Blades shall be of single unit air foil design 6 in. wide.
   2. Frames shall be extruded aluminum channel with grooved inserts for vinyl seals. Standard frames: 2 in x 4 in x 5/8 in on linkage side, 1 in x 4 in x 1 in on the other sides.
   3. Pivot rods shall be 7/8 in hexagon extruded aluminum interlocking into blade section. Bearings shall be of a double sealed type with a Celcon inner bearing on rod with a Polycannonate outer bearing inserted into frame so that the outer bearing cannot rotate.
   4. Bearing shall be designed so that there is not a metal-to-metal or metal-to-bearing riding surfaces. Interconnecting linkage shall have a separate Celcon bearing to eliminate friction in linkage.
   5. Blade linkage hardware shall be installed in frame out of air-stream. All hardware shall be on on-corrosive reinforced material of cadmium plated steel.
   6. Damper seals shall be designed for minimum air leakage by means of overlapping seals.
   7. Jack shaft assemblies shall be provided for multiple damper installations.
   8. Mixing dampers shall be parallel blades directed towards each other to promote good mixing.

2.11 FILTER SECTION

A. Pre Filters: Comply with NFPA 90A.
   1. Pre Filter Section: Provide filter media holding frames arranged for flat or angular orientation, with access doors entering the service corridor of unit.
   2. Filters shall be Merv 8 efficient, pleated, disposable type. Each filter shall consist of a non-woven cotton and synthetic fabric media, media support grid and enclosing frame. The filter, shall be listed by Underwriters' Laboratories as Class 2.
   3. Filters shall be installed in a prefabricated channel rack.
   4. Filters shall be lift-out where access is available upstream of the filter, or side out when access is not available.
   5. Provide Dwyer 2000 magnehelic gauges.
   6. Magnehelic gauges shall be accurate to "2% of full range.
   7. Sensing probes and shut off valves shall be provided for each gauge.
   8. One gauge shall be provided for each filter bank.
   9. Gauges shall be recessed into cabinet casing.

2.12 HUMIDIFIER

A. Furnish and install where indicated on the drawings packaged steam injection type humidifier panel(s).

B. Each Manifold panel shall consist of a steam supply header/separator, a condensate collection header, and a bank of closley spaced steam dispersion tubes spanning the distance between the two headers. Each tube shall be fitted with steam discharge tubelets inserted into the tube wall. These tubelets shall be made of a material designed for steam temperatures. Each tubelet shall contain a steam orifice sized for its required steam capacity.

C. Each packaged humidifier panel assembly of tubes and headers shall be contained within a galvanized metal casing to allow convenient duct mounting or to facilitate the stacking of and/or the end to end mounting of multiple Manifold panels in ducts or air handler casings.

D. All tubes and headers shall be of 304 stainless steel and joints shall be heli-arc welded. Tubes shall be jointed to headers with slip or threaded fit couplers or they can be welded.

E. The humidifier shall be furnished with appropriate steam valve, steam strainer and steam traps (when used), all shipped loose for installation on the job. The humidifier and piping shall not rise the temperature in the air stream more than 2 degrees F.

F. Approved manufacturers: Dri-Steam, Armstrong, Pure Steam.

2.13 LIGHTS

A. Marine lights with protective cast metal cage and glass globes complete with duplex receptacles shall be installed on the wall across from the access doors. A switch with an indicator light shall be installed on the unit. Electrical power shall be 120V/1/60.

2.14 PAINTING

A. The exterior and interior of both indoor and outdoor units shall be 7,000 hour salt spray powder coat. The color shall be selected by the architect. All uncoated steel shall be powder coated gray.

2.15 ELECTRICAL

A. Label and number code all wiring and electrical devices in accordance with the unit electrical diagram. Mount the devices in a control panel inside the unit's service enclosure or on the outside. Ensure the control panel meets the CSA, ETL or UL.

B. Provide factory mounted distribution panel complete with individual motor disconnects and overload protection. Factory wire from individual motors to distribution panel and provide a single point of electrical connection to a junction box mounted on the exterior of the unit. Wire from the motors to the junction box in accordance with CSA, ETL or UL and contained by EMT conduit with liquid tight connections. Seal the casing penetrations in a manner that eliminates air leaks.

C. Manufacturer to wire lighting and duplex receptacle circuit to a single switch with an indicator light near the supply fan access door. Wiring shall be in accordance with CSA, ETL or UL and contained by EMT conduit with liquid tight connections. Seal the casing penetrations in a manner that eliminates air leaks utilizing rubber gromets or other types of sealing compounds.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions to receive equipment, for compliance with installation tolerances and other conditions affecting performance of central-station air-handling units.

B. Examine roughing-in of steam, hydronic, condensate drainage piping, and electrical to verify actual locations of connections before installation.

C. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install custom air-handling units level and plumb, according to manufacturer's written instructions.
   1. Floor-Mounted Units: Support on concrete housekeeping curbs. Secure units to anchor bolts.

B. Arrange installation of units to provide access space around air-handling units for service and maintenance.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. The Drawings indicate the general arrangement of piping, fittings, and specialties. The following are specific connection requirements:

1. Install piping adjacent to machine to allow service and maintenance.
2. Connect condensate drain pans using 1-1/4-inch NPS, Type M copper tubing. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.
3. Water Piping: Conform to applicable requirements of Division 23 Section "Hydronic Piping." Connect to supply and return coil tappings with shutoff or balancing valve and union or flange at each connection.

B. Duct installation and connection requirements are specified in other Division 23 Sections. The Drawings indicate the general arrangement of ducts and duct accessories.

C. Electrical: Conform to applicable requirements of Division 23 Sections.

1. Connect fan motors to wiring systems and to ground. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
2. Temperature control wiring and interlock wiring is specified in Division 23.

3.4 ADJUSTING

A. Adjust damper linkages for proper damper operation.

3.5 CLEANING

A. After completing installation, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes including chips, scratches, and abrasions.

B. Clean fan interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheels, cabinets, and coils entering air face.

3.6 COMMISSIONING

A. Manufacturer's Field Inspection: Engage a factory-authorized service representative to perform the following:

1. Inspect field assembly of components and installation of central-station air-handling units including piping, ductwork, and electrical connections.
2. Prepare a written report on findings and recommended corrective actions.

B. Final Checks before Startup: Perform the following 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 for piping, ductwork, and electrical are complete. Verify that proper thermal overload protection is installed in motors, starters, and disconnects.
3. Perform cleaning and adjusting specified in this Section.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify free fan wheel rotation and smooth bearings operations. Reconnect fan drive system, align belts, and install belt guards.
5. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.
6. Set outside-air and return-air mixing dampers to minimum outside-air setting.
7. Comb coil fins for parallel orientation.
8. Install clean filters.
9. Verify that manual and automatic volume control, and fire and smoke dampers in connected ductwork systems are in fully open position.

C. Starting procedures for central-station air-handling units include the following:

1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm. Replace fan and motor pulleys as required to achieve design conditions.
2. Measure and record motor electrical values for voltage and amperage.
3. Manually operate dampers from fully closed to fully open position and record fan performance.

D. Refer to Division 23 Section "Testing, Adjusting, and Balancing" for air-handling system testing, adjusting, and balancing.

3.7 DEMONSTRATION

A. Engage the services of a factory-authorized service representative to train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.

1. Review data in the operation and maintenance manuals. Refer to Division 1 Section "Contract Closeout."
2. Schedule training with Owner, through Architect, with at least 7 days' advance notice.

END OF SECTION 237326

SECTION 238128 - 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. This Section includes split-system air-conditioning units consisting of separate evaporator-fan and compressor-condenser components. Units are designed for exposed or concealed mounting, and may be connected to ducts.

1.3 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

D. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of split-system 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. Energy-Efficiency Ratio: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

D. Coefficient of Performance: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

E. Units shall be designed to operate with HCFC-free refrigerants.

1.5 COORDINATION

A. Coordinate size and location of concrete bases for units. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete."

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Mitsubishi Electronics America, Inc.; HVAC Division.
2. Carrier
3. Sanyo

2.2 WALL-MOUNTING, EVAPORATOR-FAN COMPONENTS

A. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect, and discharge drain pans with drain connection.

B. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with thermal-expansion valve.

C. Fan: Direct drive, centrifugal fan.

D. Fan Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

1. Special Motor Features: Multi-tapped, multispeed with internal thermal protection and permanent lubrication.

E. Filters: Permanent, cleanable.

2.3 AIR-COOLED, COMPRESSOR-CONDENSER COMPONENTS

A. Casing: Steel, finished with baked enamel in color selected by Architect, 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.

B. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.

1. Compressor Type: Reciprocating or Scroll.
2. Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
3. Refrigerant Charge: R-407C or R-410A.

C. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with liquid sub-cooler.

D. Fan: Aluminum-propeller type, directly connected to motor.

E. Motor: Permanently lubricated, with integral thermal-overload protection.

F. Low Ambient Kit: Permits operation down to 0 deg F.

G. Mounting Base: Polyethylene.

2.4 ACCESSORIES

A. Thermostat: Low voltage with sub-base to control compressor and evaporator fan.

B. Automatic-reset timer to prevent rapid cycling of compressor.

C. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.

D. Provide Condensate pump.

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 ground-mounting, compressor-condenser components on 4-inch- thick, reinforced concrete base that is 4 inches larger, on each side, than unit. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete." Coordinate anchor installation with concrete base.

D. Install seismic restraints.

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. Install piping adjacent to unit to allow service and maintenance.

C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

D. Electrical Connections: Comply with requirements in Division 26 Sections for power wiring, switches, and motor controls.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Leak Test: After installation, charge system and test for leaks. 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.

3.4 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.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 238128

SECTION 238236 - FINNED-TUBE RADIATION HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes **hydronic** finned-tube radiation heaters.

1.3 DESCRIPTION OF WORK

A. Extent of terminal unit work is indicated by drawings and schedules, and by requirements of this section.

B. Refer to other Division-23sections for piping; ductwork; and testing, adjusting and balancing of finned-tube radiation units.

C. Refer to Division-26 sections for the following work.
   1. Power supply wiring from power source to power connection on finned-tube radiation unit. Include starters, disconnects, and required electrical devices, except where specified as furnished, or factory-installed, by manufacturer.

D. Provide the following electrical work as work of this section, complying with requirements of Division-26 sections:
   1. Control wiring between field-installed controls, indicating devices, and finned-tube radiation unit control panels.
      a. Control wiring specified as work of Division-23 for Automatic Temperature Controls is work of that section.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

   1. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings:

   1. Include plans, elevations, sections, and details.

2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include details and dimensions of custom-fabricated enclosures.
4. Indicate location and size of each field connection.
5. Indicate location and arrangement of piping valves and specialties.
6. Indicate location and arrangement of integral controls.
7. Include enclosure joints, corner pieces, access doors, and other accessories.
8. Include diagrams for power, signal, and control wiring.

C. Samples: For each exposed product and for each color and texture specified.

D. Color Samples for Initial Selection: For finned-tube radiation heaters with factory-applied color finishes.

E. Color Samples for Verification: For each type of exposed finish.

1.5 INFORMATIONAL SUBMITTALS

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

1. Structural members, including wall construction, to which finned-tube radiation heaters will be attached.
2. Method of attaching finned-tube radiation heaters to building structure.
3. Penetrations of fire-rated wall and floor assemblies.

B. Field quality-control reports.

PART 2 - PRODUCTS

2.1 HOT-WATER FINNED-TUBE RADIATION HEATERS

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

1. Dunham-Bush, Inc.
2. Edwards Engineering Corp.
3. Slant/Fin Corp.
4. Standard Fin-Pipe Radiator Corp.
5. Sterling HVAC Products; Mestek, Inc.
6. Ted Reed Thermal, Inc.
7. Trane.
8. Vulcan Radiator Co.

B. Performance Ratings: Rate finned-tube radiation heaters according to Hydronics Institute's "I=B=R Testing and Rating Standard for Finned-Tube (Commercial) Radiation."

A. Heating Elements: Copper tubing mechanically expanded into flanged collars to eliminate noise and insure durability and performance at scheduled ratings. Elements to consist of evenly spaced aluminum fins resting on element supports. One end of tube shall be belled. See Drawing Schedules for the following capacities and characteristics.

B. Element Supports: Ball-bearing cradle type to permit longitudinal movement on enclosure brackets.

C. Front Panel: Minimum **17GA-0.0538-inch-** thick steel.

D. Rust-Resistant Front Panel: **Minimum 16GA-0.064-inch- thick**, ASTM A 653, G60 galvanized steel.

E. Wall-Mounted Back Panel: Minimum **0.0329-inch-** thick steel, full height, with full-length channel support for front panel without exposed fasteners.

F. Floor-Mounted Pedestals: Conceal insulated piping at maximum 36-inch spacing. Pedestal-mounted back panel shall be solid panel matching front panel. Provide stainless-steel escutcheon for floor openings at pedestals.

G. Support Brackets: Locate at maximum **36-inch** spacing to support front panel and element.

H. Finish: Baked **-enamel** finish in manufacturer's **standard** color as selected by Architect.

I. Damper: Knob-operated internal damper at enclosure outlet.

J. Access Doors: Factory made, permanently hinged with tamper-resistant fastener, minimum size 6 by 7 inches, integral with enclosure.

K. Enclosure Style: **Flat top**.

1. **Front Inlet Grille:** Extruded-aluminum linear bar grille; pencil-proof bar spacing.

   a. Mill-finish aluminum.

   b. Anodized finish, color as selected by Architect from manufacturer's **standard** colors.

   c. Painted to match enclosure.

2. **Outlet Grille**: Extruded-aluminum linear bar grille; pencil-proof bar spacing.

   a. Top Outlet.

   b. Mill-finish aluminum.

   c. Anodized finish, color as selected by Architect from manufacturer's **standard** colors.

d. Painted to match enclosure.

L. Accessories: Filler sections, corners, relay sections, and splice plates all matching the enclosure and grille finishes.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive finned-tube radiation heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for **hydronic-piping** connections to verify actual locations before installation of finned-tube radiation heaters.

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

3.2 FINNED-TUBE RADIATION HEATER INSTALLATION

A. General: Install finned tube radiation as indicated, and in accordance with manufacturer's installation instructions.

B. Install units level and plumb.

C. Install enclosure continuously around corners, using outside and inside corner fittings.

D. Join sections with splice plates and filler pieces to provide continuous enclosure.

E. Install access doors for access to valves.

F. Locate finned tube radiation on outside walls as indicated. Install enclosure continuously from wall to wall.

G. Terminate enclosures with manufacturer's end caps except where enclosures are indicated to extend to adjoining walls.

H. Install valves within reach of access door provided in enclosure.

I. Install air-seal gasket between wall and recessed flanges or front cover of fully recessed unit.

J. Install piping within pedestals for freestanding units.

K. Center elements under windows. Where multiple windows occur over units, divide elements into equal segments centered under each window.

L. lnstall end caps where units butt against walls. lnstall access panels centered in front of each shutoff valve, balancing cock, steam trap, or temperature control valve.

3.3 CONNECTIONS

A. Piping installation requirements are specified in Division 23 "Hydronic Piping" and Division 23 Hydronic Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect hot-water finned-tube radiation heaters and components to piping according to Division-23 "Hydronic Piping" and Division-23 Hydronic Piping Specialties."

1. Install shutoff valves on inlet and outlet, and balancing valve on outlet.

C. Install control valves as required by Division-23 "Instrumentation and Control for HVAC."

D. Install piping adjacent to finned-tube radiation heaters to allow service and maintenance.

E. Connect wiring according to Division-26 "Low-Voltage Electrical Power Conductors and Cables."

F. lnstall electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electric Installer.

G. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division-26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.

3.4 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
4. Appearance Test: After construction is completed, including painting, clean unit exposed surfaces, vacuum clean terminal coils and inside of cabinets.
   a. Retouch any marred or scratched surfaces of factory-finished cabinets, using finish materials furnished by manufacturer.

B. Units will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION 238236

SECTION 238239.16 - PROPELLER 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 propeller unit heaters with **hot-water** coils.

1.3 DEFINITIONS

A. BAS: Building automation system.

B. CWP: Cold working pressure.

C. PTFE: Polytetrafluoroethylene plastic.

D. TFE: Tetrafluoroethylene plastic.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. LEED Submittals:

1. Product Data for Prerequisite IEQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."

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 location and size of each field connection.
4. Include details of anchorages and attachments to structure and to supported equipment.

5. Include equipment schedules to indicate rated capacities, operating characteristics, furnished specialties, and accessories.
6. Indicate location and arrangement of piping valves and specialties.
7. Wiring Diagrams: Power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

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

1. Suspended ceiling components.
2. Structural members to which propeller 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.

B. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For propeller unit heaters to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Airtherm.
2. Buffalo Forge Co.
3. Dunham-Bush Inc.
4. McQuay International; Daikin Industries.
5. Ted Reed Thermal, Inc.
6. Trane.
7. Wing (The) Co.

8. Young Radiator Co.

2.2 DESCRIPTION

A. Assembly including casing, coil, fan, and motor in **vertical and horizontal** discharge configuration with adjustable discharge louvers.

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.

2.3 PERFORMANCE REQUIREMENTS

A. (LEED) ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

B. (LEED) ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

2.4 HOUSINGS

A. **Finish**: Manufacturer's **standard** baked enamel applied to factory-assembled and -tested propeller unit heaters before shipping.

B. (LEED) Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

C. Discharge Louver: Adjustable fin diffuser for horizontal units and conical diffuser for vertical units.

2.5 COILS

A. **General Coil Requirements**: Test and rate propeller unit-heater coils according to ASHRAE 33 in the following application:
   1. **Hot-water**.

B. **Hot-Water Coil**: Copper tube, minimum **0.025**-inch wall thickness, with mechanically bonded aluminum fins spaced no closer than **0.1** inch and rated for a minimum working pressure of **200** psig and a maximum entering-water temperature of **325** deg F, with manual air vent. Test for leaks to **350** psig underwater.

2.6 FAN AND MOTOR

A. Fan: Propeller type with aluminum wheel directly mounted on motor shaft in the fan venturi.

B. **Motor**: Permanently lubricated, **multispeed**. Comply with requirements in Division 23 "Common Motor Requirements for HVAC Equipment."

2.7 CONTROLS

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive propeller unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping and electrical connections to verify actual locations before unit-heater installation.

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

3.2 INSTALLATION

A. Install propeller unit heaters to comply with NFPA 90A.

B. Install propeller unit heaters level and plumb.

C. Suspend propeller unit heaters from structure with all-thread hanger rods and **elastomeric hangers**. Hanger rods and attachments to structure are specified in Division 23 "Hangers and Supports for HVAC Piping and Equipment." Vibration hangers are specified in **Division 23 "Vibration Controls for HVAC."**

3.3 CONNECTIONS

A. Piping installation requirements are specified in Division 23 "Hydronic Piping," Section 232116 Hydronic Piping Specialties," Division 23 "Steam and Condensate Heating Piping," and Division 23 “Steam and Condensate Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.

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

C. Connect piping to propeller unit heater's factory, hot-water piping package. Install the piping package if shipped loose.

D. Unless otherwise indicated, install union and gate or ball valve on supply-water connection and union and calibrated balancing valve on return-water connection of propeller unit heater. Hydronic specialties are specified in Division 23 "Hydronic Piping" and Division 23 Hydronic Piping Specialties."

E. Unless otherwise indicated, install union and gate or ball valve on steam-supply connection and union, strainer, steam trap, and gate or ball valve on condensate-return connection of propeller unit heater. Steam specialties are specified in Division 23 Steam and Condensate Piping Specialties."

F. Ground equipment according to Division 26 "Grounding and Bonding for Electrical Systems."

G. Connect wiring according to Division 26 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

B. Units will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.5 ADJUSTING

A. Adjust initial temperature set points.

B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to **two** visits to Project during other-than-normal occupancy hours for this purpose.

3.6 DEMONSTRATION

A. **Train** Owner's maintenance personnel to adjust, operate, and maintain propeller unit heaters.

END OF SECTION 238239.16

SECTION 238316 - UNDERFLOOR RADIANT-HEATING 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 radiant-heating and snowmelt piping, including pipes, fittings, and piping specialties.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

B. PEX: Crosslinked polyethylene.

C. PEX/AL/PEX: Crosslinked polyethylene/aluminum/crosslinked polyethylene.

D. PTFE: Polytetrafluoroethylene plastic.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include data for piping, fittings, manifolds, specialties, and controls; include pressure and temperature ratings, oxygen-barrier performance, fire-performance characteristics, and water-flow and pressure-drop characteristics.
2. Certification of compliance with ASTM and ANSI manufacturing requirements for pipe, fittings, and specialties.
3. Provide detailed printout from manufacturer’s radiant calculation program showing fluid flows, pressure drops, pipe depth and spacing and btu output of each radiant tube assembly.

B. Shop Drawings: Provide 1/4" scale heating circuits layout including valves, manifolds, controls, and support assemblies, and their attachments to building structure.

C. Source quality-control test reports.

D. Startup service reports.

1.5 SEQUENCING AND SCHEDULING

A. Coordinate the size and location of manifold access doors and enclosures.

B. Coordinate the installation of pipe sleeves for foundation wall penetrations.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For radiant-heating piping valves and equipment to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 PEX PIPE AND FITTINGS

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

1. Uponor.
2. Viega.
3. Watts Radiant, inc.; a Watts Water Technologies company.

B. Pipe Material: PEX plastic according to ASTM F 876.

C. Oxygen Barrier: Limit oxygen diffusion through the tube to maximum 0.10 mg per cu. m/day at 104 deg F (40 deg C) according to DIN 4726.

D. Fittings: ASTM F 1807, metal insert and copper crimp rings.

E. Pressure/Temperature Rating: Minimum 100 psig (690 kPa) and 180 deg F (82 deg C).

2.2 EPDM PIPE AND FITTINGS

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

1. Watts Radiant, inc.; a Watts Water Technologies company.

B. Pipe Material: Crosslinked EPDM inner and outer tubes.

C. Wall Thickness: Minimum 0.125 inch (3.2 mm).

D. Oxygen Barrier: Ductile aluminum foil layer applied to the inner tube to limit oxygen diffusion through the pipe to maximum 0.10 mg per cu. m/day at 104 deg F (40 deg C) according to DIN 4726.

E. Reinforcing Braid: Braided-aluminum wire between the inner and outer tube.

F. Fittings: ASTM F 1807, copper with stainless-steel crimps or clamps.

G. Pressure/Temperature Rating: Minimum 100 psig (690 kPa) and 210 deg F (99 deg C).

2.3 DISTRIBUTION MANIFOLDS

A. Manifold: Minimum NPS 1 (DN 25), brass or copper.

B. Main Shutoff Valves:

1. Factory installed on supply and return connections.
2. Body: Brass or bronze.
3. Ball: Chrome-plated bronze.
4. Seals: PTFE.
5. CWP Rating: 150 psig (1035 kPa).
6. Maximum Operating Temperature: 225 deg F (107 deg C).

C. Manual Air Vents:

1. Body: Bronze.
2. Internal Parts: Nonferrous.
3. Operator: Key furnished with valve, or screwdriver bit.
4. Inlet Connection: NPS 1/2 (DN 15).
5. Discharge Connection: NPS 1/8 (DN 6).
6. CWP Rating: 150 psig (1035 kPa).
7. Maximum Operating Temperature: 225 deg F (107 deg C).

D. Mounting Brackets: Copper, or plastic- or copper-clad steel, where in contact with manifold.

2.4 PIPING SPECIALTIES

A. Cable Ties:

1. Fungus-inert, self-extinguishing, one-piece, self-locking, Type 6/6 nylon cable ties.
2. Minimum Width: 1/8 inch (3 mm).
3. Tensile Strength: 20 lb (9 kg), minimum.
4. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces and substrates to receive radiant-heating piping for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. Ensure that surfaces and pipes in contact with radiant-heating piping are free of burrs and sharp protrusions.
2. Ensure that surfaces and substrates are level and plumb.

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

3.2 APPLICATIONS

A. Install the following types of radiant-heating piping for the applications described:

1. Piping in Exterior Pavement: PEX or EPDM.
2. Piping in Interior Reinforced-Concrete Floors: PEX or EPDM.
3. Piping in Level Fill Concrete Floors (Not Reinforced): PEX or EPDM.

3.3 INSTALLATION

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 Shop Drawings or coordination drawings.

B. Install radiant-heating piping continuous from the manifold through the heated panel and back to the manifold without piping joints in heated panels.

C. Connect radiant piping to manifold in a reverse-return arrangement.

D. Do not bend pipes in radii smaller than manufacturer's minimum bend radius dimensions.

E. Install manifolds in accessible locations, or install access panels to provide maintenance access as required in Section 083113 "Access Doors and Frames."

F. Provide cast-in-place concrete or factory manufactured valve box for snowmelt manifolds. Box shall include heavy duty, vandal proof access cover with non-slip surface and shall be suitable for heavy foot traffic. Lightweight sprinkler boxes will not be accepted. Cover shall be constructed of corrosion resistant material or hot dip galvanized steel with epoxy enamel finish. Color to be selected by architect.

G. Comply with requirements in Section 232113 "Hydronic Piping" and Section 232116 Hydronic Piping Specialties" for pipes and connections to hydronic systems and for glycol-solution fill requirements.

H. Fire- and Smoke-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials according to Section 078413 "Penetration Firestopping."

I. Piping in Exterior Pavement:

1. Secure piping in concrete floors by attaching pipes to reinforcement using cable ties.
2. Space cable ties a maximum of 18 inches (457 mm) o.c. and at center of turns or bends.
3. Maintain 2-inch (75-mm) minimum cover.
4. Install a sleeve of 3/8-inch- (9.5-mm-) thick, foam-type insulation or PE pipe around tubing and extending for a minimum of 10 inches (250 mm) on each side of slab joints to protect the tubing passing through expansion or control joints. Anchor sleeve to slab form at control joints to provide maximum clearance for saw cut.
5. Maintain minimum 40-psig (275-kPa) pressure in piping during concrete placement and continue for 24 hours after placement.
6. Snowmelt tube spacing shall be a maximum of 12” O.C.

J. Piping in Interior Reinforced-Concrete Floors:

1. Secure piping in concrete floors by attaching pipes to reinforcement using cable ties.
2. Space cable ties a maximum of 18 inches (457 mm) o.c. and at center of turns or bends.
3. Maintain 2-inch (75-mm) minimum cover.
4. Install a sleeve of 3/8-inch- (9.5-mm-) thick, foam-type insulation or PE pipe around tubing and extending for a minimum of 10 inches (250 mm) on each side of slab joints to protect the tubing passing through expansion or control joints. Anchor sleeve to slab form at control joints to provide maximum clearance for saw cut.
5. Maintain minimum 40-psig (275-kPa) pressure in piping during concrete placement and continue for 24 hours after placement.
6. Radiant tube spacing shall be a maximum of 9” O.C.

K. Piping in Level Fill Concrete Floors (Not Reinforced):

1. Secure piping in concrete floors by attaching pipes to reinforcement using cable ties.
2. Space cable ties a maximum of 18 inches (457 mm) o.c. and at center of turns or bends.
3. Maintain 2-inch (75-mm) minimum cover.
4. Install a sleeve of 3/8-inch- (9.5-mm-) thick, foam-type insulation or PE pipe around tubing and extending for a minimum of 10 inches (250 mm) on each side of slab joints to protect the tubing passing through expansion or control joints. Anchor sleeve to slab form at control joints to provide maximum clearance for saw cut.
5. Maintain minimum 40-psig (275-kPa) pressure in piping during concrete placement and continue for 24 hours after placement.
6. Radiant tube spacing shall be a maximum of 9” O.C.

L. Revise locations and elevations from those indicated as required to suit field conditions and ensure integrity of piping and as approved by Architect.

M. After system balancing has been completed, mark balancing valves to permanently indicate final position.

N. Perform the following adjustments before operating the system:

1. Open valves to fully open position.
2. Check operation of automatic valves.
3. Set temperature controls so all zones call for full flow.
4. Purge air from piping.

O. After concrete has cured as recommended by concrete supplier, operate radiant-heating system as follows:

1. Start system heating at a maximum of 10 deg F (6 deg C) above the ambient radiant-panel temperature and increase 10 deg F (6 deg C) each following day until design temperature is achieved.
2. For freeze protection, operate at a minimum of 60 deg F (16 deg C) supply-water temperature.

3.4 FIELD QUALITY CONTROL

A. Prepare radiant-heating piping for testing as follows:

1. Open all isolation valves and close bypass valves.
2. Open and verify operation of zone control valves.
3. Flush with clean water and clean strainers.

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

1. Leak Test: After installation, charge system and test for leaks. Subject piping to hydrostatic test pressure that is not less than 1.5 times the design pressure but not more than 100 psig (690 kPa). Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Radiant-heating piping will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

E. Protect hydronic piping system from damage during construction.

END OF SECTION 238316

SECTION 26 0500 - ELECTRICAL GENERAL PROVISIONS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. Architectural, Structural, Mechanical and other applicable documents are considered a part of the electrical documents insofar as they apply as if referred to in full.

1.2 DESCRIPTION OF WORK:

A. The extent of electrical work is indicated on drawings and/or specified in Divisions 26, 27 and 28 sections of the specification. Provide all labor, materials, equipment, supervision and service necessary for a complete electrical system. Work includes, but is not necessarily limited to, the following items.

	ITEM	SECTION
1.	Electrical General Provisions	26 0500
2.	Electrical Connections for Equipment	26 0507
3.	Conductors and Cables	26 0519
4.	Grounding	26 0526
5.	Supporting Devices	26 0529
6.	Conduit Raceway	26 0532
7.	Electrical Boxes and Fittings	26 0533
8.	Electrical Seismic Control	26 0548
9.	Electrical Identification	26 0553
10.	Occupancy Sensors	26 0923
11.	Lighting Control Equipment	26 0943
12.	Transformers	26 2200
13.	Switchgear and Switchboards	26 2413
14.	Panelboards	26 2416
15.	Service Entrance	26 2713
16.	Wiring Devices	26 2726
17.	Overcurrent Protective Devices	26 2815
18.	Motor and Circuit Disconnects	26 2816
19.	Motor Starters	26 2913
20.	Variable Frequency Drives	26 2923
21.	Emergency Electrical Systems	26 3213
22.	Power Factor Correction	26 3533
23.	Surge Protective Devices (SPD)	26 4313
24.	Interior and Exterior Building Lighting	26 5100
25.	Exterior Area Lighting	26 5600
26.	Telephone/Data Systems	27 1500

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27.	Television System (Raceways)	27 4132
28.	Security Systems (Raceways)	28 1601
29.	Fire Alarm and Detection System	28 3111

B. Use of standard industry symbols together with the special symbols, notes, and instructions indicated on the drawings describe the work, materials, apparatus and systems required as a portion of this work.

C. Visit the site during the bidding period to determine existing conditions affecting electrical and other work. All costs arising from site conditions and/or preparation shall be included in the base bid. No additional charges will be allowed due to inadequate site inspection.

1.3 DEFINITION OF TERMS

A. The following terms used in Divisions 26, 27 and 28 documents are defined as follows:

1. "Provide": Means furnish, install and connect, unless otherwise indicated.
2. "Furnish": Means purchase and deliver to project site.
3. "Install": Means to physically install the items in-place.
4. "Connect": Means make final electrical connections for a complete operating piece of equipment.

1.4 RELATED SECTIONS:

A. Consult all other sections, determine the extent and character of related work and properly coordinate work specified herein with that specified elsewhere to produce a complete installation.

B. General and Supplementary Conditions: Drawings and general provisions of contract and Division 1 of the Specifications, apply to all Division 26, 27 and 28 sections.

C. Earthwork:

1. Provide trenching, backfilling, boring and soil compaction as required for the installation of underground conduit, buried cable, in-grade pull boxes, manholes, lighting pole foundations, etc. See Division 31, Sitework, and other portions of Divisions 26, 27 and 28, for material and installation requirements.

D. Concrete Work:

1. Provide forming, steel bar reinforcing, cast-in-place concrete, finishing and grouting as required for underground conduit encasement, light pole foundations, pull box slabs, vaults, equipment pads, etc. See Division 3, Concrete for material and installation requirements.

E. Miscellaneous Metal Work:

1. Provide fittings, brackets, backing, supports, rods, welding and pipe as required for support and bracing of raceways, lighting fixtures, panelboards, distribution

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boards, switchboards, motor controls centers, etc. See Division 5, Metals for material and installation requirements.

F. Miscellaneous Lumber and Framing Work:

1. Provide wood grounds, nailers, blocking, fasteners, and anchorage for support of electrical materials and equipment. See Division 6, Rough Carpentry for material and installation requirements.

G. Moisture Protection:

1. Provide membrane clamps, sheet metal flashing, counter flashing, caulking and sealants as required for waterproofing of conduit penetrations and sealing penetrations in or through fire walls, floors and ceiling slabs and foundation walls. All penetrations through vapor barriers at slabs on grade shall be taped and made vaportight. See Division 7, Thermal and Moisture Protection for material and installation requirements.

H. Access panels and doors:

1. Provide in walls, ceiling, and floors for access to electrical devices and equipment. See Division 8, Doors and Windows for material and installation requirements.

I. Painting:

1. Provide surface preparation, priming and finish coating as required for electrical cabinets, exposed conduit, pull and junction boxes, poles, surface metal raceways, etc. See Division 9, Finishes for material and installation requirements.

1.5 WORK FURNISHED AND INSTALLED UNDER ANOTHER SECTION REQUIRING CONNECTIONS UNDER THIS SECTION:

A. Provide electrical service, make requisite connections and perform operational test. Items furnished and installed under other sections and connected under this section, include but are not limited to the following:

1. Electric motors.
2. Package mechanical equipment: fans, fan coil units, pumps, boilers, duplex compressors, etc.
3. Flow switches and valve monitors.
4. Motorized dampers.
5. Fire and smoke dampers
6. Duct mounted smoke detectors.
7. Irrigation controllers.
8. Door hold-open/release devices.
9. Roll down doors.
10. Electric hardware.
11. Temperature control panels.

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12. Variable frequency controllers.
13. Chiller starters.
14. Display cases.
15. Water coolers.
16. Fire sprinkler alarm bells.

1.6 ITEMS FURNISHED UNDER ANOTHER DIVISION, BUT INSTALLED AND CONNECTED UNDER THIS DIVISION:

A. Items furnished under other Divisions, but turned over to Division 26 for installation and final connection include, but are not necessarily limited to, the following:

1. Wall mounted control stations for motorized roll-up doors/grills.

1.7 WORK NOT INCLUDED IN THIS DIVISION:

A. Items of work provided under another contract include, but are not necessarily limited to, the following:

1. Control wires for irrigation control valves.
2. Energy management/temperature control system; both line and low voltage including conductors and conduit.
3. Television monitors and projection equipment.
4. Security system equipment, cables, fittings, and coverplates.
5. CCTV cabling and electronic equipment.
6. MATV cabling and electronic equipment

1.8 INTERPRETATION OF DRAWINGS AND SPECIFICATIONS:

A. Before bidding, Contractor shall familiarize himself with the drawings, specifications and project site. Submit requests for clarification to Architect/Engineer in writing prior to issuance of final addendum. After signing the contract, the Contractor shall meet the intent, purpose, and function of the Contract Documents. Any costs of materials, labor and equipment arising therefrom, to make each system complete and operable, is the responsibility of the Contractor.

1.9 QUALITY ASSURANCE:

A. Reference to codes, standards, specifications and recommendations of technical societies, trade organizations and governmental agencies refers to the latest edition of such publications adopted and published prior to submittal of the bid proposed, unless noted otherwise herein. Such codes or standards are considered a part of this specification as though fully repeated herein.

B. When codes, standards, regulations, etc. allow work of lesser quality or extent than is specified under this Division, nothing in said codes shall be construed or inferred as

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reducing the quality, requirements or extent of the Drawings and Specifications. Perform work in accordance with applicable requirements of all governing codes, rules and regulations including the following minimum standards, whether statutory or not:

1. National Electric Code (NEC).
2. International Building Code (IBC).
3. International Fire Code (IFC).
4. International Mechanical Code (IMC).

C. Standards: Comply with the following standards where applicable for equipment and materials specified under this Division.

1.	UL	Underwriters' Laboratories
2.	ASTM	American Society for Testing Materials
3.	CBN	Certified Ballast Manufacturers
4.	IPCEA	Insulated Power Cable Engineers Association
5.	NEMA	National Electrical Manufacturer's Association
6.	ANSI	American National Standards Institute
7.	ETL	Electrical Testing Laboratories

D. All electrical apparatus furnished under this Section shall conform to (NEMA) standards and the NEC and bear the Underwriters' Laboratories (UL) label where such label is applicable.

E. Comply with requirements of State and Local Ordinances. If a conflict occurs between these requirements and the Contract Documents, the most stringent requirements shall govern. The Contractor accepts this responsibility upon submitting his bid, and no extra charge will be allowed after the contract is awarded. This shall not be construed as relieving the Contractor from complying with any requirements of the Contract Documents which may be in excess of the aforementioned requirements, and not contrary to same.

F. Obtain all permits, inspections, etc. required by authority having jurisdiction. Include all fees in bid. Furnish a certificate of approval to the Owner's Representative from the Inspection Authority at completion of the work.

G. Employ only qualified craftsmen with at least three years of experience. Workmanship shall be neat, have a good mechanical appearance and conform to best electrical construction practices. Provide a competent superintendent to direct the work at all times. Any person found incompetent shall be discharged from the project and replaced by satisfactory personnel.

H. Contractor shall have a current state contracting license applicable to type of work to be performed under this contract.

I. Required Pre-Electrical Construction Meeting with Electrical Engineer: Electrical contractor/representative will be required to attend a pre-electrical construction meeting

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(approximately 30-60 minutes) with Engineering representative in the electrical engineers office prior to electrical construction commencement. This meeting will address any questions on the part of the contractor and the expectations of the Engineer with regard to specifications, plans and site visits for both rough and finish electrical work.

1.10 SUBMITTALS:

A. SHOP DRAWINGS AND PRODUCT DATA:

1. After the Contract is awarded but prior to manufacture or installation of any equipment, prepare complete Shop Drawings and Brochures for materials and equipment as required by each section of the specification. Submit 8 complete sets for review. All sets of shop drawing material shall be bound. Prior to submission of the Shop Drawings and Project Data, review and certify that they are in compliance with the Contract Documents. Verify all dimensional information to ensure proper clearance for installation of equipment. Check all materials and equipment after arrival on the job site and verify compliance with the Contract Documents. A minimum period of two weeks, exclusive of transmittal time, will be required each time Shop Drawing and/or Brochure is submitted or resubmitted for review. This time period shall be considered by the Contractor when scheduling submittal data. If the shop drawings are rejected twice, the contractor shall reimburse the engineer the sum of $200.00 for the third review and any additional reviews required.

2. Review of Shop Drawings and Brochures shall not relieve the Contractor of responsibility for dimensions and/or errors that may be contained therein, or deviations from the Contract Document's requirements. It shall be clearly understood that the noting of some errors but overlooking others does not grant the Contractor permission to proceed in error. Regardless of any information contained in the Shop Drawings and Brochures, the requirements of the Contract Document's shall govern and are not waived, or superseded in any way by the review of the Shop Drawings and Brochures.

3. Certifications shall be written or in the form of rubber stamp impressions as follows:

a. I hereby certify that this Shop Drawing and/or Brochure has been checked prior to submittal and that it complies in all respects with the requirements of the Contract Drawings and Specifications for this Project.

(Name of Electrical Subcontractor)

Signed_____.

Position_____Date_____

4. Observe the following rules when submitting the Shop Drawings and Brochures.

a. Each Shop Drawing shall indicate in the lower right hand corner, and each Brochure shall indicate on the front cover the following: Title of the

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sheet or brochure, name and location of the building; names of the Architect and Electrical Engineer, Contractor, Subcontractors, Manufacturer, Supplier/Vendor, etc., date of submittal, and the date of correction and revision. Unless the above information is included the submittal will be returned for resubmittal.

b. Shop Drawings shall be done in an easily legible scale and shall contain sufficient plans, elevations, sections, and isometrics to clearly describe the equipment or apparatus, and its location. Drawings shall be prepared by an Engineer/Draftsmen skilled in this type of work. Shop Drawings shall be drawn to at least 1/4" = 1'0" scale.

c. Brochures to be submitted shall be published by the Manufacturers and shall contain complete and detailed engineering and dimensional information. Brochures submitted shall contain only information relevant to the particular equipment or materials to be furnished. The Contractor shall not submit catalogs which describe several different items in addition to those items to be used, unless all irrelevant information is marked out, or unless relevant information is clearly marked. Brochures from each manufacturer shall be identified and submitted separately.

5. ELECTRONIC SUBMITTAL REQUIREMENTS:

a. Provide submittals in Portable Document Format (PDF).

b. Documents must be electronically bookmarked and keyword searchable using Adobe Acrobat (http://www.adobe.com/acrobat) or Bluebeam Revu (http://www.bluebeam.com) for each relevant section. For example, include electronic bookmarks separating “Light Fixtures” from “Panelboards”.

c. Electronically highlight all options for light fixtures, electrical equipment, etc. Manual highlighting and scanning of the documents is NOT acceptable and will NOT be reviewed.

d. Provide only completed cutsheets for all fixture and equipment types. Blank cutsheets submitted with a schedule are NOT acceptable and will NOT be reviewed.

e. A maximum of one submittal per specification section is allowed. It is NOT acceptable to provide a product by product submittal. Single product by product submittals will NOT be reviewed.

1.11 OPERATION AND MAINTENANCE MANUALS:

A. Provide operating instruction and maintenance data books for all equipment and materials furnished under this Division.

B. Submit four copies of operating and maintenance data books for review at least four weeks before final review of the project. Assemble all data in a completely indexed volume or volumes and identify the size, model, and features indicated for each item. The binder (sized to the material) shall be a 2" slide lock unit (Wilson-Jones WLJ36544B).

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The cover shall be engraved with the job title in 1/2" high letters and the name and address of the Contractor in 1/4" high letters. Provide the same information in 1/8" letters on the spine.

C. Include complete cleaning and servicing data compiled in clearly and easily understandable form. Show serial numbers of each piece of equipment, complete lists of replacement parts, motor ratings, etc. Each unit shall have its own individual sheet. (Example: If two items of equipment A and D appear on the same sheet, an individual sheet shall be provided for each unit specified).

D. Include the following information where applicable.

1. Identifying name and mark number.
2. Certified outline Drawings and Shop Drawings.
3. Parts lists.
4. Performance curves and data.
5. Wiring diagrams.
6. Light fixture schedule with the lamps and ballast data used on the project for all fixtures
7. Manufacturer's recommended operating and maintenance instructions.
8. Vendor's name and address for each item.

E. The engineer shall review the manuals and when approved, will forward the manuals on to the architect. If the manuals are rejected twice, the contractor shall reimburse the engineer the sum of $200.00 for each review afterwards.

1.12 RECORD DRAWINGS:

A. Maintain, on a daily basis, a complete set of “Record Drawings”, reflecting an accurate record of work in accordance with the following:

1. Show the complete routing and location of all feeders rated 100 amps and larger. Locate work buried below grade or under slab, work concealed above ceilings, and work in concealed spaces, dimensionally from fixed structural elements (not partition walls, etc.)
2. Show the complete routing and location of all telecommunications conduits, systems raceways, and empty raceways, 1-1/4" and larger. Locate work buried below grade or under slab, work concealed above ceilings, and work in concealed spaces, dimensionally from fixed structural elements (not partition walls, etc.).
3. Show all changes, deviations, addendum items, change orders, job instructions, etc., which change the work from that shown on the contract documents, including wall relocations, fixtures and device changes, branch circuiting changes, etc. Where locations of boxes, raceways, equipment, etc. are adjusted in the field to fit conditions, but such new locations may not be obvious by referring to the contract document, show new locations on the record drawings.

B. At the discretion of the Architect/Engineer, the drawings will be reviewed on a periodic

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basis and used as a pre-requisite for progress payments. This requirement shall not be construed as authorization for the Contractor to make changes in the layout, or work without written authorization for such changes. The "Record Drawings" for daily recording shall consist of a set of blue line prints of the Contract Drawings.

C. Upon completion of the work, purchase a complete set of electronic drawings. Transfer all "Record" information from the blue line prints to the drawings via the current CAD program in which it was written. The Architect/Engineer shall review the drawings and the Contractor shall incorporate the resulting comments into the final record drawings. The Contractor shall make two complete copies of the drawings electronically and forward this to the Engineer.

D. Certify the "Record Drawings" for correctness by placing and signing the following certifications of the first sheet of the drawings:

1. "CERTIFIED CORRECT (3/8" high letters)
   (Name of General Contractor)

"CERTIFIED CORRECT (3/8" high letters)

(Name of General Contractor)

By: _____ Date: _____

(Name of Electrical Contractor)

By: _____ Date: _____

1.13 GUARANTEE:

A. Ensure that electrical system installed under this contract is in proper working order and in compliance with drawings, specifications, and/or authorized changes. Without additional charge, replace any work or materials which develop defect, except from ordinary wear and tear, within one year from the date of substantial completion. Exception: Incandescent and fluorescent lamps shall be guaranteed for a period of two months from the date of substantial completion.

PART 2 – PRODUCTS

2.1 GENERAL:

A. Products are specified by manufacturer name, description, and/or catalog number. Discrepancies between equipment specified and the intended function of equipment shall be brought to the attention of the Architect/Engineer in writing prior to bidding. Failure to report any conflict, including catalog numbers, discontinued products, etc., does not relieve the Contractor from meeting the intent of the contract documents nor shall it change the contract cost. If the Contractor is unable to interpret any part of the plans and/or specifications, or should he find discrepancies therein, he shall bring this to the

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attention of the Architect/Engineer who will issue interpretation and/or additional instructions to Bidders before the project is bid.

2.2 MANUFACTURERS:

A. Provide products of manufacturers specified. Manufacturers catalog numbers and descriptions establish the quality of product required. Substitutions will be considered if a duplicate written application (2-copies) is at the office of the Architect/Engineer eight (8) working days prior to the day of the bidding. The application shall include the following: 1) A statement certifying that the equipment proposed is equal to that specified; that it has the same electrical and physical characteristics, compatible dimensions, and meets the functional intent of the contract documents; 2) The specified and submittal catalog numbers of the equipment under consideration; 3) A pictorial and specification brochure.

B. Any conflict arising from the use of substituted equipment shall be the responsibility of the Contractor, who shall bear all costs required to make the equipment comply with the intent of the contract documents.

C. Samples may be required for non-standard or substituted items before installation during construction. Provide all samples as required.

D. No materials or apparatus may be substituted after the bid opening except where the equipment specified has been discontinued.

E. Provide only equipment specified in the Contract Documents or approved by addendum.

2.3 SPARE PARTS:

A. Provide spare parts (fuses, diffusers, lamps, etc.) as specified. Transmit all spare parts to Owner's Representative prior to substantial completion.

PART 3 – EXECUTION

3.1 INSTALLATION:

A. Layout electrical work in advance of construction to eliminate unnecessary cutting, drilling, channeling, etc. Where such cutting, drilling, or channeling becomes necessary for proper installation; perform with care. Use skilled mechanics of the trades involved. Repair damage to building and equipment at no additional cost to the contract. Cutting work of other Contractors shall be done only with the consent of that Contractor. Cutting structural members shall not be permitted.

B. Since the drawings of floor, wall, and ceiling installation are made at small scale; outlets, devices, equipment, etc., are indicated only in their approximate location unless dimensioned. Locate outlets and apparatus symmetrically on floors, walls and ceilings where not dimensioned, and coordinate such locations with work of other trades to prevent interferences. Verify all dimensions on the job. Do not scale the electrical

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drawings, but refer to the architectural and mechanical shop drawings and project drawings for dimensions as applicable.

C. Perform for other trades, the electrical wiring and connection for all devices, equipment or apparatus. Consult Architectural, Mechanical, and other applicable drawings, and all applicable shop drawings to avoid switches, outlets, and other equipment from being hidden behind doors, cabinets, counters, heating equipment, etc., or from being located in chalkboards, tackboards, glass panels, etc. Relocate buried electrical devices and/or connections as directed at no additional cost.

D. Coordinate the location of outlets, devices, connections, and equipment with the supplier of the systems furniture prior to rough-in.

E. Where conduit, outlets or apparatus are to be encased in concrete, it must be located and secured by a journeyman or foreman present at the point of installation. Check locations of the electrical items before and after concrete and/or masonry installation and relocate displaced items.

F. Provide block-outs, sleeves, demolition work, etc., required for installation of work specified in this division.

3.2 CLEAN:

A. Clean up all equipment, conduit, fittings, packing cartons and other debris that is a direct result of the installation of the work of this Division.

B. Clean fixtures, interiors and exteriors of all equipment, and raceways. Replace all filters in electrical equipment upon request for Substantial Completion.

3.3 POWER OUTAGES:

A. All power outages required for execution of this work shall occur during non-standard working hours and at the convenience of the Owner. Include all costs for overtime work in bid.

B. Submit written request at least 7 days in advance of scheduled outage and proceed with outage only after receiving authorization from the Owner's Representative.

C. Keep all outages to an absolute minimum.

3.4 STORAGE AND PROTECTION OF MATERIALS:

A. Provide storage space for storage of materials and apparatus and assume complete responsibility for all losses due to any cause whatsoever. In no case shall storage interfere with traffic conditions in any public thoroughfare or constitute a hazard to persons in the vicinity. Protect completed work, work underway, and apparatus against loss or damage.

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3.5 EXCAVATING FOR ELECTRICAL WORK:

A. General: Locate and protect existing utilities and other underground work in manner which will ensure that no damage or service interruption will result from excavating and backfilling. Perform excavation in a manner which protects walls, footings, and other structural members from being disturbed or damaged in any way. Burial depths must comply with NEC Section 300-5 (or State of Utah requirement, whichever is more stringent), unless noted otherwise on drawings.

B. Protect persons from injury at excavations, by barricades, warnings and illumination.

C. Coordinate excavations with weather conditions, to minimize possibility of washouts, settlements and other damages and hazards.

D. Provide temporary covering or enclosure and temporary heat as necessary to protect bottoms of excavations from freezing and frost action. Do not install electrical work on frozen excavation bases or sub-bases.

E. Do not excavate for electrical work until the work is ready to proceed without delay, so that total time lapse from excavation to completion of backfilling will be minimum. See other sections of specification for additional requirements for excavating.

F. Store excavated material (temporarily) near excavation, in manner which will not interfere with or damage excavation or other work. Do not store under trees (within drip line).

G. Retain excavated material which complies with requirements for backfill material. Dispose of excavated material which is either in excess of quantity needed for backfilling or does not comply with requirements for backfill material. Remove unused material from project site, and dispose of in lawful manner.

3.6 BACKFILL MATERIALS:

A. For buried conduit or cable (other than below slab-on-grade, or concrete encased) - 2" thickness of well graded sand on all side of conduit or cable.

B. For trench backfill to within 6" of final grade - soil material suitable for compacting to required densities.

C. For top 6" of excavation - Top soil.

D. Backfill excavations in 8" high courses of backfill material, uniformly compacted to the following densities (percent of maximum density, ASTM D 1557), using power-driven hand-operated compaction equipment.

1. Lawn/Landscaped Areas: 85 percent for cohesive soils, 95 percent for cohesionless soils.

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2. Paved Areas, Other than Roadways (90 percent for cohesive soils, 95 percent for cohesionless soils).

E. Subsidence: Where subsidence is measurable or observable at electrical work excavations during general project warranty period, remove surface (pavement, lawn or other finish), add backfill material, compact, and replace surface treatment. Restore appearance, quality and condition of the surface or finish to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.7 CONCRETE BASES:

A. Unless otherwise noted, provide 4" high reinforced concrete bases for all floor mounted or floor standing electrical equipment, including generators, transformers, switchgear, battery racks, motor control centers, etc. Extend bases 6" beyond equipment or mounting rails on all sides or as shown on the drawings. Notwithstanding this requirement, coordinate with equipment manufacturer, shop drawings, and height of base to ensure compliance with NEC 404.8.

B. Concrete bases shall be provided under Divisions 26, 27 and 28. Coordinate size and location of all bases and furnish all required anchor bolts, sleeves, reinforcing and templates as required to obtain a proper installation.

C. Provide and locate properly sized concrete pads for power company furnished pad mounted transformers in accordance with power company clearance requirements. Where the serving utility is Rocky Mountain Power, the electrical contractor shall conform to the requirements of Electrical Service Requirements, Section 6.4.

3.8 ROOF PENETRATIONS:

A. Where raceways penetrate roofing or similar structural area, provide appropriate roof jack coordinate with the roofing contractor and the Architect in order to match the vent with the roof construction. The jack shall be sized to fit tightly to raceway for weather-tight seal, and with flange extending a minimum of 9" under roofing in all sides or as required by the roof type of construction. Completely seal opening between inside diameter of roof flashing and outside diameter of penetrating raceways. Coordinate all work with work required under roofing section of specifications.

3.9 FIRE PENETRATION SEALS:

A. Seal all penetrations for work of this section through fire rated floors, walls and ceilings to prevent the spread of smoke, fire, toxic gas or water through the penetration either before, during or after fire. The fire rating of the penetration seal shall be at least that of the floor, wall or ceiling into which it is installed, so that the original fire rating of the floor or wall is maintained as required by Article 300-21 of the National Electrical Code. Where applicable, provide OZ Type CFSF/I and CAFSF/I fire seal fittings for conduit and cable penetrations through concrete and masonry walls, floors, slabs, and similar structures. Where applicable, provide 3M fire barrier sealing penetration system, and/or IPC Flame Safe Fire Stop System, and/or Chase Foam fire stop system, including wall

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wrap, partitions, caps, and other accessories as required. All materials to comply with UL 1479 (ASTM E-814). Comply with manufacturer's instructions and recommendations for installation of sealing fittings and barrier sealing systems.

3.10 PROJECT FINALIZATION AND START-UP:

A. Upon completion of equipment and system installation, assemble all equipment Factory Representatives and Subcontractors for system start-up.

B. Each Representative and Subcontractor shall assist in start-up and check out their respective system and remain at the site until the total system operation is accepted by the Owner's representative.

C. The Factory Representative and/or System Subcontractor shall give personal instruction on operating and maintenance of their equipment to the Owner's maintenance and/or operation personnel. To certify acceptance of operation and instruction by the Owner's Representative, the contractor shall prepare a written statement as follows:

1. This is to certify that the Factory Representative and System Subcontractor for each of the systems listed below have performed start-up and final check out of their respective systems.
2. The Owner's Representative has received complete and thorough instruction in the operation and maintenance of each system.

SYSTEM	FACTORY REPRESENTATIVE
(List systems included)	(List name and address of Factory Representative).
_____	_____
Owner's Representative	Contractor

D. Send copy of acceptance to Architect/Engineer.

3.11 FINAL REVIEW:

A. At the time of final review, the project foreman shall accompany the reviewing party, and remove coverplates, panel covers and other access panels as requested, to allow review of the entire electrical system.

END OF SECTION 26 0500

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SECTION 26 0507 - ELECTRICAL CONNECTIONS FOR EQUIPMENT

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. This section is a Division-26 Basic Materials and Methods section, and is part of each Division-26 section making reference to electrical connections.

1.2 DESCRIPTION OF WORK:

A. Extent of electrical connection for equipment includes final electrical connection of all equipment having electrical requirements. Make final connections for all owner furnished equipment. See other applicable portions of specification for building temperature control wiring requirements.

B. Refer to Division-23 sections for motor starters and controls furnished integrally with equipment; not work of this section.

C. Refer to Division- 23 section for control system wiring; not work of this section.

D. Refer to sections of other Divisions for specific individual equipment power requirements.

1.3 QUALITY ASSURANCE:

A. NEC COMPLIANCE: Comply with applicable portions of NEC as to type products used and installation of electrical power connections.

B. UL LABELS: Provide electrical connection products and materials which have been UL-listed and labeled.

PART 2 – PRODUCTS

2.1 GENERAL:

A. For each electrical connection indicated, provide complete assembly of materials, including but not necessarily limited to, raceways, conductors, cords, cord caps, wiring devices, pressure connectors, terminals (lugs), electrical insulating tape, heat-shrinkable insulating tubing, cable ties, solderless wire nuts, and other items and accessories as needed to complete splices, terminations, and connections as required. Crimp on or slip-on type splicing materials (insulation displacement type) designed to be used without wire stripping are not acceptable. See Section 260532, Conduit Raceway; Section 262726 Wiring Devices: and Section 260519 Conductors and Cables for additional requirements. Provide final connections for equipment consistent with the following:

B. Permanently installed fixed equipment - flexible seal-tite conduit from branch circuit terminal equipment, or raceway; to equipment, control cabinet, terminal junction box or wiring terminals. Totally enclose all wiring in raceway.

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C. Movable and/or portable equipment - wiring device, cord cap, and multi-conductor cord suitable for the equipment and in accordance with NEC requirements (Article 400).

D. Other methods as required by the National Electrical Code and/or as required by special equipment or field conditions.

PART 3 – EXECUTION

3.1 INSTALLATION OF ELECTRICAL CONNECTIONS:

A. Make electrical connections in accordance with connector manufacturer's written instructions and with recognized industry practices, and complying with requirements of NEC and NECA's "Standard of Installation" to ensure that products fulfill requirements.

B. Connect electrical power supply conductors to equipment conductors in accordance with equipment manufacturer's written instructions and wiring diagrams.

C. Coordinate installation of electrical connections for equipment with equipment installation work.

D. Verify all electrical loads (voltage, phase, horse power, full load amperes, number and point of connections, minimum circuit ampacity, etc.) for equipment furnished under other Divisions of this specification, by reviewing respective shop drawings furnished under each division. Meet with each subcontractor furnishing equipment requiring electrical service and review equipment electrical characteristics. Report any variances from electrical characteristics noted on the electrical drawings to Architect before proceeding with rough-work. In summary it is not in the Electrical Engineers scope to review the shop drawings from other trades/divisions.

E. Obtain and review the equipment shop drawings to determine particular final connection requirements before rough-in begins for each equipment item.

F. Refer to basic materials and methods Section 26 0553 Electrical Identification, Conductors, for identification of electrical power supply conductor terminations.

END OF SECTION 26 0507

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SECTION 26 0519 - CONDUCTORS AND CABLES (600V AND BELOW)

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. This section is a Division-26 Basic Materials and Methods section, and is part of each Division-26 section making reference to conductors and cables specified herein.

1.2 DESCRIPTION OF WORK:

A. Extent of electrical conductor and electrical cable work is indicated by drawings and schedules.

B. Types of conductors and cables in this section include the following:

1. Copper Conductors (600V)

C. Applications for conductors and cables required for project include:

1. Power Distribution
2. Feeders
3. Branch Circuits

1.3 QUALITY ASSURANCE:

A. Comply with NEC as applicable to construction and installation of electrical conductors and cable. Comply with UL standards and provide electrical conductors and cables which have been UL-listed and labeled.

B. Comply with applicable portions of NEMA/Insulated Cable Engineers Association standards pertaining to materials, construction and testing of conductors and cable.

C. Comply with applicable portions of ANSI/ASTM and IEEE standards pertaining to construction of conductors and cable.

1.4 SUBMITTALS:

A. FIELD TEST DATA:

1. Submit megohmmeter test data for circuits under 600 volts.

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PART 2 - PRODUCTS

2.1 COPPER CONDUCTORS (600V):

A. Provide factory-fabricated conductors of sizes, ratings, materials, and types indicated for each service. Where not indicated provide proper selection to comply with project's installation requirements and NEC standards. Provide conductors in accordance with the following:

1. Service Entrance Conductors – Copper conductor; see drawings for insulation type.
2. Distribution and Panelboard Feeders; and Other Conductors, #2 AWG and Larger – Copper conductor; see drawings for insulation type.
3. Branch Circuit Conductors and All Conductors #3 AWG and Smaller - Copper conductor, with THHN/THWN insulation. Size all conductors in accordance with NEC; minimum size to be #12 AWG. Provide stranded conductors for #8 AWG and larger.

B. Provide a maximum of three phase conductors in any one conduit or as approved by electrical engineer. Where phase conductors share a common neutral they must have a means to simultaneously disconnect all ungrounded conductors at the point where the branch circuits originate. The ungrounded and neutral conductors of a multi-wire branch circuit must be grouped together by wire ties at the point of origination. Provide neutral and ground wire as specified elsewhere in documents.

C. Provide separate neutral conductor for all single phase branch circuits installed. No shared neutrals are allowed. Neutral conductor shall be the same size as the phase conductor.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. General: Install electric conductors and cables as indicated, in compliance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standards of Installation", and in accordance with recognized industry practices.

B. Coordinate installation work with electrical raceway and equipment installation work, as necessary for proper interface.

C. Cables may be pulled by direct attachment to conductors or by use of basket weave pulling grip applied over cables. Attachment to pulling device shall be made through approved swivel connection. Nonmetallic jacketed cables of small size may be pulled directly by conductors by forming them into a loop to which pull wire can be attached; remove insulation from conductors before forming the loop. Larger sizes of cable may be pulled by using basket weave pulling grip, provided the pulling force does not exceed

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limits recommended by manufacturer; if pulling more than one cable, bind them together with friction tape before applying the grip. For long pulls requiring heavy pulling force, use pulling eyes attached to conductors.

D. Do not exceed manufacturer's recommendations for maximum allowable pulling tension, side wall pressure, and minimum allowable bending radius. In all cases, pulling tension applied to the conductors shall be limited to 0.008 lbs. per circular mil of conductor cross-section area.

E. Pull in cable from the end having the sharpest bend; i.e. bend shall be closest to reel. Keep pulling tension to minimum by liberal use of lubricant, and turning of reel, and slack feeding of cable into duct entrance. Employ not less than one man at reel and one in pullhole during this operation.

F. For training of cables, minimum bend radius to inner surface of cable shall be 12 times cable diameter.

G. Where cable is pulled under tension over sheaves, conduit bends, or other curved surfaces, make minimum bend radius 50% greater than specified above for training.

H. Use only wire and cable pulling compound recommended by the specific cable manufacturer, and which is listed by UL.

I. Seal all cable ends unless splicing is to be done immediately. Conduit bodies shall not contain splices.

J. Support all cables in pullholes, concrete trenches, and similar locations by cable racks and secure to rack insulators with nylon cord or self-locking nylon cable ties. Place each cable on separate insulator. In manholes, pullholes, concrete trenches, and similar locations, wrap strips of fire-proofing tape (approx. 1/16 inch thick by 3 inches wide) tightly around each cable spirally in half-lapped wrapping or in two butt-joined wrappings with the second wrapping covering the joints in the first. Apply tape with the coated side toward the cable, and extend tape one inch into the ducts. To prevent unraveling, random wrap the fireproofing tape the entire length of the fireproofing with pressure sensitive glass cloth tape. Provide fireproofing tape of a flexible, conformable fabric having one side coated with flame retardant, flexible, polymeric coating and/or a chlorinated elastomer not less than 0.050 inch thick weighing not less than 2.5 pounds per square yard. Provide tape which is noncorrosive to cable sheath, self-extinguishing, and which will not support combustion. Construct tape of materials which do not deteriorate when subjected to oil, water, gases, salt water, sewage and fungus.

K. Follow manufacturer's instructions for splicing and cable terminations.

3.2 AFTER INSTALLATION TEST FOR CABLE 600 VOLTS AND BELOW:

A. Prior to energization, test cable and wire for continuity of circuitry, and for short circuits, Megger all circuits of 100 amp and greater rating. Correct malfunctions. Submit record in triplicate of megohmmeter readings to Architect/Engineer.

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B. Subsequent to wire and cable connections, energize circuitry and demonstrate functioning in accordance with requirements.

C. Electrical Identification: Refer to Section 260553 for requirements.

END OF SECTION 26 0519

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SECTION 26 0526 - GROUNDING

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. Division-26 Basic Materials and Methods sections apply to work specified in this section.

1.2 DESCRIPTION OF WORK:

A. Provide grounding as specified herein, and as indicated on drawings.

B. Provide grounding and bonding of all electrical and communication apparatus, machinery, appliances, building components, and items required by the NEC to provide a permanent, continuous, low impedance, grounding system.

C. Unless otherwise indicated, ground the complete electrical installation including the system neutral, metallic conduits and raceways, boxes, fittings, devices, cabinets, and equipment in accordance with all code requirements.

D. Ground each separately derived system, as described in NEC Section 250-30, unless otherwise indicated.

E. Types of grounding in this section include the following:

1. Underground Metal Water Piping
2. Metal Building Frames
3. Grounding Electrodes
4. Grounding Rods
5. Reference Ground Buses
6. Isolated Grounding Systems
7. Separately Derived Systems
8. Service Equipment
9. Enclosures
10. Systems
11. Equipment
12. Other items indicated on drawings

F. Requirements of this section apply to electrical grounding work specified elsewhere in these specifications.

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1.3 QUALITY ASSURANCE:

A. Comply with NEC as applicable to electrical grounding and ground fault protection systems. Comply with applicable ANSI and IEEE requirements. Provide products which have been UL listed and labeled.

B. Resistance from the service entrance ground bus, through the grounding electrode to earth, shall not exceed 5 ohms.

1.4 SUBMITTALS:

A. Submit the name of test agency to be used for testing specified in this section. Submit results of tests specified in this section. Also include test results in Operation and Maintenance Manuals as specified.

PART 2 – PRODUCTS

2.1 MATERIALS AND COMPONENTS:

A. GENERAL: Except as otherwise indicated, provide each electrical grounding system as specified herein, and as shown on drawings, including but not necessarily limited to, cables/wires, connectors, terminals (solderless lugs), grounding rods/electrodes and plate electrodes, bonding jumper braid, and other items and accessories needed for complete installation. Where materials or components are not otherwise indicated, comply with NEC, NEMA and established industry standards for applications indicated.

B. ELECTRICAL GROUNDING CONDUCTORS: Unless otherwise indicated, provide electrical grounding conductors for grounding connections matching power supply wiring materials and sized according to NEC. Provide with green insulation.

C. GROUND RODS: Steel with copper welded exterior, 3/4" dia. x 10' long. Weaver or Cadweld.

D. GROUND WELL BOXES FOR GROUND RODS: Precast concrete box 9-1/2" W. x 16" L. X 18" D. with light duty concrete cover for non-traffic areas or rated steel plate for traffic areas. Provide covers with lifting holes. Engrave cover with "GROUND ROD".

E. CONCRETE ENCASED GROUNDING ELECTRODE (UFER GROUND): #2/0 AWG bare copper conductor.

F. INSULATED GROUNDING BUSHINGS: Plated malleable iron body with 150 degree Centigrade molded plastic insulating throat, lay-in grounding lug with hardened stainless steel fasteners, OZ-Gedney BLG, or Thomas & Betts #TIGB series.

G. CONNECTIONS TO PIPE: For cable to pipe, OZ-Gedney G-100B series or Thomas & Betts #390X series, or Burndy type GAR.

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H. CONNECTIONS TO STRUCTURAL STEEL, GROUND RODS, OR SPLICES: For splicing and/or connecting conductors, use exothermic welds or high pressure compression type connectors. Provide exothermic weld kits manufactured by Cadweld or Thermoweld. If high compression type connectors are used for cable-to-cable, or cable-to-steel, or cable-to-ground rod connections, provide Thomas & Betts #53000 series, or Burndy Hyground series.

I. BONDING JUMPERS: OZ-Gedney Type BJ, or Thomas & Betts #3840 series, or Burndy type GG and type B braid.

J. MAIN BUILDING REFERENCE GROUND BUS: Provide one 18" L. X 2" H X 1/4" thick copper bus bar (or size noted on drawings). Mount on walls in locations shown, on insulating stand offs, 18" AFF. Furnish complete with lugs for connecting grounding system cables. All holes shall be drilled and tapped for single hole lugs. Provide 6 spare lugs and 6 lug spaces.

K. INTERSYSTEM BONDING TERMINAL: Provide one 12” L. x 2” H x ¼” thick copper bus bar. Mount on wall adjacent to Main Electrical Service Equipment on insulating standoffs, 18” A.F.F. Furnish complete with lugs for connecting systems grounding cables. All holes shall be drilled for 2 hole compression lugs. Provide 6 spare lugs. Connect to equipment grounding bus in Main Electrical Service Equipment with No. 4 AWG copper conductor.

PART 3 - EXECUTION

3.1 INSTALLATION OF GROUNDING SYSTEMS:

A. Install electrical grounding systems in accordance with manufacturer's written instructions and with recognized industry practices to ensure grounding devices comply with requirements.

B. Install clamp-on connectors only on thoroughly cleaned and metal contact surfaces, to ensure electrical conductivity and circuit integrity.

C. Provide grounding for the entire raceway, enclosure, equipment and device system in accordance with NEC. All non-metallic raceways shall include copper grounding conductor sized in accordance with NEC. Include copper grounding conductor in all raceway installed in suspended slabs.

D. Provide service entrance grounding by means of ground rods (quantity of two, driven exterior to building), by means of bonding to water main, and by means of bonding to building structural steel. In addition, provide a grounding electrode for not less than 30 lineal feet in concrete footing or foundation which is in direct contract with earth. Size electrode in accordance with NEC, but in no case, smaller than No. 4 AWG bare copper. Support electrode so as to be below finished grade near the bottom of the trench, and approximately three inches from the bottom or sides of the concrete. Locate a point of connection for inspection.

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E. Provide grounding conductors for dimming systems in accordance with manufacturer's requirement.

3.2 GROUNDING ELECTRODES:

A. Concrete Encased Grounding Electrode (UFER Ground): Provide a #2/0 AWG minimum bare copper conductor encased along the bottom of concrete foundation or footings which are in direct contact with the earth and where there is no impervious water-proofing membrane between the footing and the soil. Extend electrode through a horizontal length of 30 feet minimum and encase with not less than 2 nor more than 5 inches of concrete separating it from surrounding soils. At point of emergence from concrete, run electrode through a protective non-metallic sleeve and extend to the main building [reference] ground bus.

B. Separately Derived Electrical System Grounding Electrode: Ground each separately derived system per requirements in NEC Section 250-26 unless indicated otherwise.

C. GROUNDING ELECTRODE CONDUCTOR: Provide grounding electrode conductor sized per NEC table 250-94 or as indicated.

D. POWER SYSTEM GROUNDING: Connect the following items using NEC sized copper grounding conductors to lugs on the Service Ground Bus.

1. Grounding electrode conductor from concrete encased electrode, from ground rods, and from service entrance ground bus.
2. Conductor from main incoming cold water piping system.
3. Conductor from building structural steel.
4. Ground for separately derived systems.

E. Run main grounding conductors exposed or in metallic conduit if protection or concealment is required.

F. EQUIPMENT BONDING/GROUNDING: Provide a NEC sized conductor, whether indicated or not on the drawings, in raceways as follows:

1. Non-metallic conduits and ducts.
2. Distribution feeders.
3. Motor and equipment branch circuits.
4. Device and lighting branch circuits.
5. Provide grounding bushings and bonding jumpers for all conduit terminating in reducing washers, concentric, eccentric or oversized knockouts at panelboards, cabinets and gutters.

G. Provide bonding jumpers across expansion and deflection couplings in conduit runs, across pipe connections at water meters, and across dielectric couplings in metallic cold water piping system.

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H. Provide bonding wire in all flexible conduit.

3.3 TESTING:

A. Obtain and record ground resistance measurements both from service entrance ground bus to the ground electrode and from the ground electrode to earth. Install additional bonding and grounding electrodes as required to comply with resistance limits specified under this Section.

B. Include typewritten records of measured resistance values in the Operation and Maintenance Manual.

C. Use independent testing agency for all testing.

D. Use test equipment expressly designed for the purpose intended. Submit name of testing agency for review and approval, in writing, to the Engineer prior to the performance of any testing.

END OF SECTION 26 0526

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SECTION 26 0529 - SUPPORTING DEVICES

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

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

B. This section is a Division-26 Basic Materials and Methods section, and is a part of each Division-26, 27 and 28 section making reference to supports, anchors, sleeves, and seals, specified herein.

1.2 DESCRIPTION OF WORK:

A. Extent of supports, anchors, and sleeves is indicated by drawings and schedules and/or specified in other Division-26 sections. See Section 260532, Raceways, for additional requirements.

B. Work of this section includes supports, anchors, sleeves and seals required for a complete raceway support system, including but not limited to: clevis hangers, riser clamps, C-clamps, beam clamps, one and two hole conduit straps, offset conduit clamps, expansion anchors, toggle bolts, threaded rods, U-channel strut systems, threaded rods and all associated accessories.

1.3 QUALITY ASSURANCE:

A. Comply with NEC as applicable to construction and installation of electrical supporting devices. Comply with applicable requirements of ANSI/NEMA Std. Pub No. FB 1, "Fittings and Supports for Conduit and Cable Assemblies". Provide electrical components which are UL-listed and labeled.

PART 2 - PRODUCTS

2.1 MANUFACTURED SUPPORTING DEVICES:

A. GENERAL:

1. Provide supporting devices; complying with manufacturer's standard materials, design and construction in accordance with published product information, and as required for a complete installation; and as herein specified. See drawings for additional requirements.

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PART 3 - EXECUTION

3.1 INSTALLATION OF SUPPORTING DEVICES:

A. Install hangers, anchors, sleeves, and seals as required, in accordance with manufacturer's written instructions and with recognized industry practices to ensure supporting devices comply with requirements. Comply with requirements of NECA, NEC and ANSI/NEMA for installation of supporting devices.

B. Coordinate with other electrical work, including raceway and wiring work, as necessary to interface installation of supporting devices with other work.

C. Install hangers, supports, clamps and attachments to support piping properly from building structures. Arrange for grouping of parallel runs of horizontal conduits to be supported together on trapeze type hangers where possible. For pre-and post tensioned construction, use pre-set inserts for support of all electrical work. Do not use toggle bolts, moly bolts, wood plugs or screws in sheetrock or plaster as support for any equipment or raceway.

D. RACEWAYS:

1. Support raceways which are rigidly attached to structure at intervals not to exceed 8 feet on center, minimum of two straps per 10 foot length of raceway, and within 12" of each junction box, coupling, outlet or fitting. Support raceway at each 90° degree bend. Support raceway (as it is installed) in accordance with the following:

NUMBER OF RUNS	3/4" TO 1-1/4" 0	1-1/2" & LARGER 0
1	Full straps, clamps or hangers.	Hanger
2	Full straps, clamps or hangers.	Mounting Channel
3 or more	Mounting Channel	Mounting Channel

2. Support suspended raceways on trapeze hanger systems; or individually by means of threaded rod and straps, clamps, or hangers suitable for the application. Do not use "tie wire" as a portion of any raceway support system; do not support raceway from ceiling support wires.

E. FLOOR MOUNTED EQUIPMENT:

1. Provide rigid attachment of all floor mounted equipment to the floor slab or structural system. Provide 5/8" bolts or expansion anchors at each 90 degree corner and at intervals not to exceed 48" on center along entire perimeter of the equipment. Provide rigid attachment for all floor mounted switchboards, panelboards, power and control equipment, motor control centers, dimmer cabinets, transformers (provide neoprene vibrations isolators at anchor points), oil switches, battery packs and racks, and similar equipment furnished under Division 26, 27 and 28.

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F. WIREWAYS AND CABLE TRAYS:

1. Provide vertical and lateral support systems for all wireways, and cable trays which are supported from overhead structure. See Sections 260536 and 262500 for additional requirements.

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SECTION 26 0532 - CONDUIT RACEWAY

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

B. This section is a Division-26 Basic Materials and Methods section, and is part of each Division-26 section making reference to electrical raceways and specified herein.

1.2 DESCRIPTION OF WORK:

A. Extent of raceways is indicated by drawings and schedules.

B. Types of raceways in this section include the following:

1. Electrical Metallic Tubing
2. Flexible Metal Conduit
3. Intermediate Metal Conduit
4. Liquid-tight Flexible Metal Conduit
5. Rigid Metal Conduit
6. Rigid Non-metallic Conduit

1.3 QUALITY ASSURANCE:

A. MANUFACTURERS: Firms regularly engaged in manufacture of raceway systems of types and sizes required, whose products have been in satisfactory use in similar service for not less than three (3) years.

B. STANDARDS: Comply with applicable portions of NEMA standards pertaining to raceways. Comply with applicable portions of UL safety standards pertaining to electrical raceway systems; and provide products and components which have been UL-listed and labeled. Comply with NEC requirements as applicable to construction and installation of raceway systems.

C. SUBMITTALS: Not required.

PART 2 – PRODUCTS

2.1 METAL CONDUIT AND TUBING:

A. GENERAL:

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1. Provide metal conduit, tubing and fittings of types, grades, sizes and weights (wall thicknesses) as indicated; with minimum trade size of 3/4".

B. RIGID METAL CONDUIT (RMC): FS WW-C-0581 and ANSI C80.1.

C. INTERMEDIATE STEEL CONDUIT (IMC): FS WW-C-581.

D. PVC EXTERNALLY COATED RIGID STEEL CONDUIT: ANSI C80.1 and NEMA Std. Pub. No. RN 1.

E. ALUMINUM CONDUIT: Not acceptable.

F. MC CABLE: Not acceptable.

G. RIGID AND INTERMEDIATE STEEL CONDUIT FITTINGS:

1. Provide fully threaded malleable steel couplings; raintight and concrete tight where required by application. Provide double locknuts and metal bushings at all conduit terminations. Install OZ Type B bushings on conduits 1-1/4" and larger.

H. ELECTRICAL METALLIC TUBING (EMT): FS WW-C-563 and ANSI C80.3.

I. EMT FITTINGS:

1. Provide insulated throat nylon bushings with non-indenter type malleable steel fittings at all conduit terminations. Install OZ Type B bushings on conduits 1" larger. Cast or indenter type fittings are not acceptable.

J. FLEXIBLE METAL CONDUIT: FS WW-C-566, of the following type;

1. Zinc-coated steel.

K. FLEXIBLE METAL CONDUIT FITTINGS: FS W-F-406, Type 1, Class 1, and Style A.

L. LIQUID TIGHT FLEXIBLE METAL CONDUIT:

1. Provide liquid-tight, flexible metal conduit; constructed of single strip, flexible continuous, interlocked, and double-wrapped steel; galvanized inside and outside; coated with liquid-tight jacket of flexible polyvinyl chloride (PVC).

M. LIQUID-TIGHT FLEXIBLE METAL CONDUIT FITTINGS: FS W-F-406, Type 1, Class 3, Style G.

N. EXPANSION FITTINGS: OZ Type AX, or equivalent to suit application.

2.2 NON-METALLIC CONDUIT AND DUCTS:

A. GENERAL:

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1. Provide non-metallic conduit, ducts and fittings of types, sizes and weights as indicated; with minimum trade size of 3/4".

B. UNDERGROUND PVC PLASTIC UTILITIES DUCT:

1. Minimum requirements shall be schedule 40 for encased burial in concrete and for Type II for direct burial.

C. PVC AND ABS PLASTIC UTILITIES DUCT FITTINGS:

D. ANSI/NEMA TC 9, match to duct type and material.

E. HDPE CONDUIT: Not acceptable.

2.3 CONDUIT; TUBING; AND DUCT ACCESSORIES:

A. Provide conduit, tubing and duct accessories of types and sizes, and materials, complying with manufacturer's published product information, which mate and match conduit and tubing. Provide manufactured spacers in all duct bank runs.

2.4 SEALING BUSHINGS:

A. Provide OZ Type FSK, WSK, or CSMI as required by application. Provide OZ type CSB internal sealing bushings.

2.5 CABLE SUPPORTS:

A. Provide OZ cable supports for vertical risers, type as required by application.

PART 3 - EXECUTION

3.1 INSTALLATION OF ELECTRICAL RACEWAYS:

A. Install electrical raceways where indicated; in accordance with manufacturer's written instructions, applicable requirements of NEC and NECA "Standard of Installation", and in accordance with the following:

1. SERVICE ENTRANCE CONDUCTORS, AND CONDUCTORS OVER 600 VOLTS:

a. Install in rigid metal conduit (RMC), or intermediate metal conduit (IMC); except where buried below grade, install in non-metallic conduit or duct, individually encased in concrete. See duct banks.

2. FEEDERS UNDER 600 VOLTS:

a. Install feeders to panels and motor control centers and individual equipment feeders rated 100 amps and greater, in rigid metal conduit (RMC), or intermediate metal conduit (IMC), or Electrical Metallic

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Tubing (EMT); except where buried below grade, install in non-metallic conduit or duct. Encase feeders 1-1/4" and larger, individually in concrete where installed below grade. See duct banks.

3. BRANCH CIRCUITS, SIGNAL AND CONTROL CIRCUITS, AND INDIVIDUAL EQUIPMENT CIRCUITS RATED LESS THAN 100 AMPS:

   a. Install in electric metallic tubing (EMT). Below concrete slab-on-grade or in earth fill, install in non-metallic plastic duct. In areas exposed to weather, moisture, or physical damage, install in RMC or IMC. In suspended slabs, install in EMT. Encase non-metallic duct 1-1/4" and larger in concrete. See duct banks.

B. Provide 1000 feet of 3/4" conduit with 3 #12 conductors and 1000 feet of 3/4" conduit with 3 #10 conductors. Provide all supports, fittings, boxes, terminations, etc. as required for installation. Install only as directed by engineer. Credit back all unused material and labor to the Owner.

C. Coordinate with other work including metal and concrete deck work, as necessary to interface installation of electrical raceways and components.

D. Install raceway in accordance with the following:

1. Provide a minimum of 12" clearance measured from outside of insulation from flues, steam and hot water piping, etc. Avoid installing raceways in immediate vicinity of boilers and similar heat emitting equipment. Conceal raceways in finished walls, ceilings and floor (other than slab-on-grade), except in mechanical, electrical and/or communication rooms, conceal all conduit and connections to motors, equipment, and surface mounted cabinets unless exposed work is indicated on the drawings. Run concealed conduits in as direct a line as possible with gradual bends. Where conduit is exposed in mechanical spaces, etc., install parallel with or at right angles to building or room structural lines. Do not install lighting raceway until piping and duct work locations have been determined in order to avoid fixtures being obstructed by overhead equipment.
2. Where cutting raceway is necessary, remove all inside and outside burrs; make cuts smooth and square with raceway. Paint all field threads (or portions of raceway where corrosion protection has been damaged) with primer and enamel finish coat to match adjacent raceway surface.
3. Provide a minimum of 1 ½” from nearest surface of the roof decking to raceway.
4. Provide a maximum of three phase conductors in any one conduit or as approved by electrical engineer. Where phase conductors share a common neutral they must have a means to simultaneously disconnect all ungrounded conductors at the point where the branch circuits originate. The ungrounded and neutral conductors of a multi-wire branch circuit must be grouped together by wire ties at the point of origination..
5. Provide neutral and ground wire as specified elsewhere in documents.

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6. Provide separate neutral conductor for all single phase branch circuits installed. No shared neutrals are allowed. Neutral conductor shall be the same size as the phase conductor.

E. Comply with NEC for requirements for installation of pull boxes in long runs.

F. Cap open ends of conduits and protect other raceways as required against accumulation of dirt and debris. Pull a mandrel and swab through all conduit before installing conductors. Install a 200 lb. nylon pull cord in each empty conduit run.

G. Replace all crushed, wrinkled or deformed raceway before installing conductors.

H. Do not use flame type devices as a heat application to bend PVC conduit. Use a heating device which supplies uniform heat over the entire area without scorching the conduit.

I. Provide rigid metal conduit (RMC) for all bends greater than 22 degrees in buried conduit. Provide protective coating for RMC bend as specified herein.

J. Where raceways penetrate building, area ways, manholes or vault walls and floors below grade, install rigid metal conduit (RMC) for a minimum distance of 10 feet on the exterior side of the floor or wall measured from interior face. Provide OZ, Type FSK, WSK or CSMI sealing bushings (with external membrane clamps as applicable) for all conduit penetrations entering walls or slabs below grade. Provide segmented type CSB internal sealing bushings in all raceways penetrating building walls and slabs below grade, and in all above grade raceway penetrations susceptible to moisture migration into building through raceway.

K. Install liquid-tight flexible conduit for connection of motors, transformers, and other electrical equipment where subject to movement and vibration.

L. Install spare 3/4" conduits (capped) from each branch panelboard into the ceiling and floor space. Run five into the ceiling space and five into the floor space. Where the floor is not accessible run six conduits into the ceiling space. Run conduits the required distance necessary to reach accessible ceiling space.

M. Provide OZ expansion fittings on all conduits crossing building expansion joints, both in slab and suspended.

N. Provide OZ cable supports in all vertical risers in accordance with NEC 300-19; type as required by application.

O. Complete installation of electrical raceways before starting installation of cables/conductors within raceways.

P. Raceway installation below grade:

1. Apply protective coating to metallic raceways in direct contact with earth or fill of any type; consisting of spirally wrapped PVC tape (1/2" minimum overlap of

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scotch wrap tape or equal); or factory applied vinyl cladding (minimum thickness .020 inches). Completely wrap and tape all field joints.

2. Burial depths must comply with NEC Section 300-5 but in no case be less than 24", unless noted otherwise on drawings.

Q. Raceway installation below slab-on-grade, or below grade:

1. For slab-on-grade construction, install runs of rigid plastic conduit (PVC) below slab. All raceway shall be located a minimum of 8” below bottom of slab. Install RMC (with protective coating) for raceways passing vertically through slab-on-grade. Slope raceways as required to drain away from electrical enclosures and to avoid collection of moisture in raceway low points.

2. Apply protective coating to metallic raceways in direct contact with earth or fill of any type; consisting of spirally wrapped PVC tape (1/2" minimum overlap of scotch wrap tape or equal); or factory applied vinyl cladding (minimum thickness .020 inches). Completely wrap and tape all field joints.

3. Mark all buried conduits which do not require concrete encasement by placing yellow plastic marker tape (minimum 6" wide) along entire length of run 12" below final grade. Where multiple small lines are buried in a common trench and do not exceed an overall width of 16", install a single line marker.

4. Burial depths must comply with NEC Section 300-5 but in no case be less than 24", unless noted otherwise on drawings.

R. Raceway installation in suspended slabs:

1. Install conduit as close to the middle of concrete slab as practicable without disturbing reinforcement. Do not install conduits of diameter greater than 1/3 of the slab thickness. Space conduits not less than 3 diameters on center (except at stub up locations). Provide OZ expansion fittings at all expansion joints. All raceways shall be installed with concrete tight fittings. Include copper ground conductor in all raceways installed in suspended slabs.

S. Raceway installation in hazardous locations:

1. Install RMC in all hazardous locations as defined by NEC. Provide suitable fittings, seal-offs, boxes, etc. to comply with requirements.

2. Engage at least five full threads on all fittings. Provide inspection fittings with explosion proof drains to prevent water accumulation in conduit runs. Install seal-offs for arcing or high temperature equipment, at housing with splices or taps and where conduits enter or leave the hazardous area. Provide seal-offs of the appropriate type for vertical or horizontal installation. Ground all metallic parts.

T. DUCTBANKS:

1. Provide ductbank construction as indicated using 3000 psi at 28 day strength concrete. Use Type II low alkali per ASTM C150. Use ASTM C-33 aggregate gradation with maximum size of 3/4". Use W/C ratio of 0.50. Install #4 reinforcing bar per ASTM 615 grade 50 in each corner of ductbank. Provide

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minimum 4" concrete cover on all sides of exterior conduits. Provide polypropylene pull rope in all spare duct.

U. Electrical Identification: Refer to Section 260553 for requirements.

END OF SECTION 26 0532

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SECTION 26 0533 - ELECTRICAL BOXES AND FITTINGS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specifications sections, apply to work of this section.

B. This section is a Division-26 Basic Materials and Methods section, and is a part of each Division-26, 27 and 28 section making reference to electrical wiring boxes and fittings specified herein. See Section 260532, Raceways, for additional requirements.

1.2 DESCRIPTION OF WORK:

A. The extent of electrical box and electrical fitting work is indicated by drawings and schedules.

B. Types of electrical boxes and fittings in this section include the following:

1. Outlet Boxes
2. Junction Boxes
3. Pull Boxes
4. Floor Boxes
5. Conduit Bodies
6. Bushings
7. Locknuts
8. Knockout Closures
9. Miscellaneous Boxes and Fittings

1.3 QUALITY ASSURANCE:

A. Comply with NEC as applicable to construction and installation of electrical boxes and fittings. Comply with ANSI C 134,1 (NEMA Standards Pub No. OS 1) as applicable to sheet-steel outlet boxes, device boxes, covers and box supports. Provide electrical boxes and fittings which have been UL-listed and labeled.

1.4 SUBMITTALS:

A. Submit manufacturer’s data including specifications, installation instruction and general recommendations for each type of floor box used on project.

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PART 2 - PRODUCTS

2.1 FABRICATED MATERIALS:

A. INTERIOR OUTLET BOXES:

1. Provide one piece, galvanized flat rolled sheet steel interior outlet wiring boxes with accessory rings, of types, shapes and sizes, including box depths, to suit each respective location and installation, construct with stamped knockouts in back and sides, and with threaded screw holes with corrosion-resistant screws for securing box and covers and wiring devices; minimum size 4"x4"x2-1/8".

2. Provide an ‘FS’ box, with no knockouts when surface mounted in a finished, non-utility space. Surface mounting is only acceptable when approved by the Architect.

B. INTERIOR OUTLET BOX ACCESSORIES:

1. Provide outlet box accessories as required for each installation, including mounting brackets, hangers, extension rings, fixture studs, cable clamps and metal straps for supporting outlet boxes, which are compatible with outlet boxes being used and fulfilling requirements of individual wiring applications.

C. WEATHERPROOF OUTLET BOXES:

1. Provide corrosion-resistant cast-metal weatherproof outlet wiring boxes, of types, shapes and sizes (including depth) required, with threaded conduit ends, cast-metal face plates with spring-hinged waterproof caps suitably configured for each application, with face plate gaskets and corrosion-resistant fasteners.

D. JUNCTION AND PULL BOXES:

1. Provide code-gage sheet steel junction and pull boxes, with screw-on covers; of types, shapes and sizes to suit each respective location and installation; with welded seams and equipped with stainless steel nuts, bolts, screws and washers.

E. FLOOR BOXES:

1. Single Service Floor Box: Provide leveling and fully adjustable floor service receptacle outlets and fittings of types and ratings indicated; and with finish as selected by Architect. Equip with wiring devices as specified in Section 262726. Provide boxes compatible with floor system; provide cast iron boxes for slab-on-grade construction; provide stamped steel boxes for suspended slabs. Equip with tile and/or carpet flanges to accommodate floor finish material. Boxes shall be available in one, two or three gang configurations. Boxes shall comply with UL Standard UL514A.

2. Multi-Service Floor Box: Provide leveling and fully adjustable multi compartment floor box; there shall be multiple independent wiring compartments; the floor box shall permit tunneling from end power compartment to end power compartment. Floor box shall accommodate a minimum of two duplex receptacles and two mounting plates for telecommunication devices.

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Equip with wiring devices as specified in Section 262726. Provide boxes compatible with floor system; with finish as selected by Architect. Provide cast-iron boxes for slab-on-grade construction; provide stamped steel boxes for suspended slabs. Equip with tile and/or carpet flanges to accommodate floor finish material. Boxes shall comply with UL Standards UL514A and/or UL514C.

3. Manufacturer: subject to compliance with requirements, provide floor boxes of one of the following:

   a. Bell Electric/Square D Co.

   b. Crouse-Hinds Co.

   c. Harvey Hubbell, Inc.

   d. Thomas & Betts.

   e. Wiremold

F. CONDUIT BODIES:

1. Provide galvanized cast-metal conduit bodies, of types, shapes and sizes to suit respective locations and installation, construct with threaded-conduit-entrance ends, removable covers, and corrosion-resistant screws.

G. BUSHINGS, KNOCKOUT CLOSURES AND LOCKNUTS:

1. Provide corrosion-resistant punched-steel box knockout closures, conduit locknuts and malleable steel conduit bushings and offset connectors, of types and sizes to suit respective uses and installation.

PART 3 - EXECUTION

3.1 INSTALLATION OF ELECTRICAL BOXES AND FITTINGS:

A. GENERAL:

1. Install electrical boxes and fittings where indicated, complying with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.
2. Coordinate installation of electrical boxes and fittings with wire/cable and raceway installation work.
3. Provide coverplates for all boxes. See Section 262726, Wiring Devices.
4. Provide weatherproof outlets for interior and exterior locations exposed to weather or moisture.
5. Provide knockout closures to cap unused knockout holes where blanks have been removed.
6. Install boxes and conduit bodies to ensure ready accessibility of electrical wiring. Do not install boxes above ducts or behind equipment. Install recessed boxes

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with face of box or ring flush with adjacent surface. Seal between switch, receptacle and other outlet box openings and adjacent surfaces with plaster, grout, or similar suitable material.

7. Fasten boxes rigidly to substrates or structural surfaces to which attached, or solidly embed electrical boxes in concrete or masonry. Use bar hangers for stud construction. Use of nails for securing boxes is prohibited. Set boxes on opposite sides of common wall with minimum 10" of conduit between them. Set boxes on opposite sides of fire resistant walls with minimum of 24” separation.
8. Provide a minimum of 1 ½” from the nearest surface of the roof decking to the installed boxes.
9. Provide electrical connections for installed boxes.

END OF SECTION 26 0533

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SECTION 26 0548 - ELECTRICAL SEISMIC CONTROL

PART 1 – GENERAL

1.1 WORK INCLUDED:

A. Anchorage and seismic restraint systems for all Division 26 isolated and non-isolated equipment, cable tray, and conduit systems.

B. Equipment/cable tray/conduit to isolated and/or seismically supported shall include but not be limited to the following:

1. Conduit
2. Cable Tray
3. Light Fixtures

1.2 RELATED WORK:

A. Requirements: Provide Electrical Seismic Control in accordance with the Contract Documents.

B. Section 260500 – Electrical General Provisions

1.3 REFERENCES:

A. International Building Code, Current Edition in use by Jurisdictional Authority.

B. NFPA Bulletin 90A, Current Edition.

C. UL Standard 181.

1.4 SYSTEM DESCRIPTION

A. The Division 26 Contractor shall be responsible for supplying and installing equipment, vibration isolators, flexible connections, rigid steel frames, anchors, inserts, hangers and attachments, supports, seismic snubbers and bracing to comply with the following:

1. Short period design spectral response acceleration coefficient SDS=0.70.
2. One second period design spectral response acceleration coefficient SD1=0.28.
3. Site Class B.
4. Seismic Design Category D.

1.5 QUALITY ASSURANCE:

A. All supports, hangers, bases, anchorage and bracing for all isolated equipment and non-isolated equipment shall be designed by a professional engineer licensed in the state where the project is located, employed by the restraint manufacturer, qualified with seismic experience in bracing for electrical equipment. Shop drawings submitted for earthquake bracing and anchors shall bear the Engineer's signed professional seal. All calculations/design work required for the seismic anchorage and restraint of all Division 26 equipment and systems shall be provided by a single firm.

B. The above qualified seismic engineer shall determine specific requirements for equipment anchorage and restraints, locations and sizes based on shop drawings for the electrical equipment which have been submitted, reviewed and accepted by the Architect/Engineer for this project.

C. Seismic Engineer or the Engineer's Representative shall field inspect final installation and certify that bracing and anchorage are in conformance with the Seismic Engineer's design. A certificate of compliance bearing the Seismic Engineer's signed Professional Engineer's seal shall be submitted and shall be included in each copy of the Operation and Maintenance Manuals.

D. The Division 26 Contractor shall require all equipment suppliers furnish equipment that meets the seismic code, with bases/skids/curb designed to receive seismic bracing and/or anchorage. All isolated and non-isolated electrical equipment bracing to be used in the project shall be designed from the Equipment Shop Drawings and certified correct by the equipment manufacturer for seismic description listed in Paragraph 1.4 above, with direct anchorage capability.

1.6 SUBMITTALS:

A. A single submittal shall be provided for all seismic anchorage and restraints for all Division 26 equipment and systems provided as part of this project. Individual submittals for specific systems will not be accepted.

B. Submit shop drawings, calculations, and printed data for the following items under provisions of the General Conditions of the Contract:

1. Complete engineering calculations and shop drawings for all seismic requirements for all equipment to be restrained as outlined in Paragraph 1.1 above, and as detailed on drawings.
2. The professional seal of the engineer who is responsible for the design of the Seismic Restraint System.
3. Details for all seismic bracing.
4. Details for steel frames, concrete inertia bases, and housekeeping pads. Include dimensions, embed depths, dowelling details, and concrete reinforcing requirements.
5. Clearly outlined procedures for installing and adjusting the isolators, seismic bracing anchors, snubbers, cables, and bolt connections.
6. Floor plan noting the locations, size, and type of anchorage and restraint to be used.
7. Include confirmation that all calculations are based on the design criteria listed in Paragraph 1.4.A of this Section.
8. Certificate of Compliance.

PART 2 – PRODUCTS:

2.1 RESTRAINT EQUIPMENT AND SYSTEMS:

A. Acceptable Manufacturers and Suppliers for Non-Isolated Systems:

1. Mason Industries, Inc.
2. Korfund
3. Amber/Booth Company
4. Vibration Mountings and Control Company
5. Kinetics
6. International Seismic Application Technology
7. Tolco

B. Manufacture and design of restraints and anchors for isolated equipment shall be by the manufacturer of the vibration isolators furnished for the equipment.

2.2 SNUBBERS:

A. Snubbers shall be all-directional and consist of interlocking steel members restrained by replaceable shock absorbent elastomeric materials a minimum of 3/4 inch thick.

B. Snubbers shall be manufactured with an air gap between hard and resilient material of not less than 1/8 inch or more than 1/4 inch.

C. Snubbers shall be Mason Industries Z -1011 or accepted equivalent.

PART 3 – EXECUTION

3.1 DESIGN AND INSTALLATION:

A. General:

1. All electrical equipment cable tray and conduit shall be braced, anchored, snubbed or supported to withstand seismic disturbances in accordance with the criteria of this specification. Provide all engineering, labor, materials, and equipment for protection against seismic disturbances as specified herein. The following electrical components are exempt from seismic restraint requirements.

a. Components in Seismic Design Categories A and B (see 1.4 above).

b. Components in Seismic Design Category C (see 1.4 above) that have an important factor IP of 1.0 (see 1.4 above).

c. Components that have an importance factor IP of 1.0 (see 1.4 above), that are mounted less than four feet above the floor, that weigh less than 400 pounds, and that have flexible ductwork, piping, and conduit connections.

d. Components that have an importance factor IP of 1.0 (see 1.4 above), that weigh 20 pounds or less, and that have flexible ductwork, piping, and conduit connections.

2. Powder-actuated fasteners (shot pins) shall not be used for component anchorage in tension applications in Seismic Design Category D, E, or F.

3. Attachments and supports for electrical equipment shall meet the following provisions:

a. Attachments and supports transferring seismic loads shall be constructed of materials suitable for the application and designed and constructed in accordance with a nationally recognized structural code such as, when constructed of steel, AISC, Manual of Steel Construction (Ref. 9.8-1 or 9.8-2).

b. Friction clips shall not be used for anchorage attachment.

c. Expansion anchors shall not be used for electrical equipment rated over 10 hp (7.45 kW). Exception: Undercut expansion anchors.

d. Drilled and grouted-in-place anchors for tensile load applications shall use either expansive cement or expansive epoxy grout.

e. Supports shall be specifically evaluated if weak-axis bending of light-gauge support steel is relied on for the seismic load path.

f. Components mounted on vibration isolation systems shall have a bumper restraint or snubber in each horizontal direction. The design force shall be taken as 2Fp. The intent is to prevent excessive movement and to avoid fracture of support springs and any non- ductile components of the isolators.

g. Seismic supports shall be constructed so that support engagement is maintained.

B. Spring Isolated Equipment:

1. All vibration isolated equipment shall be mounted on rigid steel frames or concrete bases as described in the vibration control specifications unless the equipment manufacturer certified direct attachment capability. Each spring mounted base shall have a minimum of four all-directional seismic snubbers that are double acting and located as close to the vibration isolators as possible to facilitate attachment both to the base and the structure. Snubbers shall be installed with factory set clearances.

C. Non-Isolated Equipment:

1. The section 260548 (Electrical Seismic Control) Contractor shall be responsible for thoroughly reviewing all drawings and specifications to determine all equipment to be restrained. This Contractor shall be responsible for certifying that this equipment is mounted and braced such that it adheres to the system description criteria in part 1.04 of this specification section.

D. Conduit:

1. Seismic braces for conduit may be omitted when the distance from the top of the conduit to the supporting structure is 12” or less.

2. A rigid conduit system shall not be braced to dissimilar parts of a building or two dissimilar building systems that may respond in a different mode during an earthquake. Examples: Wall and a roof; solid concrete wall and a metal deck with lightweight concrete fill.

3. Unbraced conduit attached to in-line equipment shall be provided with adequate flexibility to accommodate differential displacements.

4. At the interface of adjacent structures or portions of the same structure that may move independently, utility lines shall be provided with adequate flexibility to accommodate the anticipated differential movement between the ground and the structure.

5. Provide large enough pipe sleeves through wall or floors to allow for anticipated differential movements.

E. Cable Tray:

1. Seismic restraints are not required for cable tray with importance factor IP of 1.0, provided that the following condition is met for the full length of each cable tray.

a. Cable trays are suspended from rod hangers and hangers that are 12” or less in length from the point rod attaches to tray, to the point rod connects to the supporting structure. Rods must be secured to both top and bottom cross angles with locking nuts above and below angle iron.

END OF SECTION 26 0548

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SECTION 26 0553 - ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. Requirements of the following Division 26 Sections apply to this section:

1. “Basic Electrical Requirements”.
2. “Basic Electrical Materials and Methods”.

1.2 SUMMARY

A. This section includes identification of electrical materials, equipment and installations. It includes requirements for electrical identification components including but not limited to the following:

1. Buried electrical line warnings.
2. Identification labels for raceways, cables and conductors.
3. Operational instruction signs.
4. Warning and caution signs.
5. Equipment labels and signs.
6. Arc-flash hazard labels

B. Related Sections: The following sections contain requirements that relate to this section:

C. Division 9 Section “Painting” for related identification requirements.

D. Refer to other Division 26 sections for additional specific electrical identification associated with specific items.

1.3 QUALITY ASSURANCE

A. Electrical Component Standard: Components and installation shall comply with NFPA 70 “National Electrical Code”

1.4 SUBMITTALS:

A. PRODUCT DATA: Submit manufacturer’s data on each type of electrical identification products.

B. SAMPLES: Submit one sample of each component of the electrical identification system

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as follows:

1. Wire/cable tape marker.
2. Tags
3. Engraved, plastic laminate labels.
4. Arc-flash hazard labels.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

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

1. American Labelmark Co.
2. Calpico, Inc.
3. Cole-Flex Corp.
4. Emed Co., Inc.
5. George-Ingraham Corp.
6. Ideal Industries, Inc.
7. Kraftbilt
8. LEM Products, Inc.
9. Markal Corp
10. National Band and Tag Co.
11. Panduit Corp.
12. Radar Engineers Div., EPIC Corp.
13. Seton Name Plate Co.
14. Standard Signs, Inc.
15. W.H Brady, Co.

2.2 ELECTRICAL IDENTIFICATION PRODUCTS

A. Colored Conduit Systems for raceway identification:

1. Factory-painted conduit and/or factory-painted couplings and fittings

B. Colored paint for raceway identification:

1. Use Kwal Paint colors as specified in Part 3 – Execution.

C. Color Adhesive Marking Tape for Raceways, Wires and Cables:

1. Self-adhesive vinyl tape not less than 3 mills thick by 1” to 2” in width.

D. Underground Line Detectable Marking Tape:

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1. Permanent, bright colored, continuous-printed, acid- and alkali-resistant plastic tape specifically compounded for direct-burial service. Not less than 6” wide by 4 mills thick.
2. With metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep.
3. Printed legend indicative of general type of underground line below.

E. Wire/Cable Designation Tape Markers:

1. Vinyl or vinyl-cloth, self-adhesive, wraparound, cable/conductor markers with pre-printed numbers and letters.

F. Brass or Aluminum Tags:

1. Metal tags with stamped legend, punched for fastener.
2. Dimensions: 2” X 2” 19 gage.

G. Engraved, Plastic Laminated Labels, Signs and Instruction Plates:

1. Engraving stock melamine plastic laminate, 1/16” minimum thickness for signs up to 20 sq. in. or 8” in length; 1/8 “ thick for larger sizes. Engraved legend in ¼” high white letters on black face and punched for mechanical fasteners.

H. Arc-flash Hazard Labels:

1. ANSI Z535.4 Safety Label.
2. Adhesive backed polyester with self-laminating flap. Chemical, abrasion and heat resistant.
3. Dimensions: 5” x 3.5”
4. Information contained: Arc-flash boundary; Voltage; Flash Hazard Category; Incident Energy (arc rating); checkboxes for the required Personal Protective Equipment (PPE) and the date that the calculations were performed.

I. Equipment Labels:

1. Adhesive backed polyester with self-laminating flap. Chemical, abrasion and heat resistant.
2. Dimensions: minimum 5” x 2”
3. Conductor-Identification-Means Labels:
   a. Information contained: the method utilized for identifying ungrounded conductors within switchboards, distribution panels and branch circuit panels.
4. Available-Fault-Current Labels:
   a. Information contained: maximum available fault current at the respective piece of equipment, and date of calculation of fault current.
5. Source-of-Supply Labels:

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a. Information contained: indicate the device or equipment where the power supply originates.

J. Baked Enamel Warning and Caution Signs for Interior Use:

1. Preprinted aluminum signs, punched for fasteners, with colors legend and size appropriate to location.

K. Fasteners for Plastic-Laminated and Metal Signs:

1. Self-tapping stainless steel screws or # 10/32 stainless steel machine screws with nuts, flat and lock washers.

L. Cable Ties:

1. Fungus-inert, self-extinguishing, one-piece, self-locking nylon cable ties, 0.18" minimum width, 50-lb. Minimum tensile strength, and suitable for a temperature range from minus 40° F. to 185° F. Provide ties for specified colors when used for color coding.

M. Colored Support Wires:

1. When electrical equipment/wiring is supported by wires within the ceiling cavity, these wires shall be independent of the ceiling support assembly and shall be distinguishable by painting entire length in bright yellow.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Lettering and Graphics:

1. Coordinate names, abbreviations, colors and other designations used in electrical identification work with corresponding designations specified or indicated. Install numbers, lettering and colors as approved in submittals and as required by code.

B. Install identification devices in accordance with manufacturer's written instructions and requirements of NEC.

C. Sequence of Work:

1. Where identification is to be applied to surfaces that require a finish, install identification after completion of finish work.

D. Conduit Identification:

1. Identify Raceways of Certain Systems with Color Coding. Acceptable means of color identification are as follows:

a. Colored adhesive marking tape.

b. Field-painted colored bands.

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c. Factory-painted conduit.

d. Color exposed or accessible raceways of the following systems for identification. Make each color band 2 inches wide, completely encircling conduit. Apply bands at changes in direction, at penetrations of walls and floors, and at 20-foot maximum intervals in straight runs. Apply the following colors:

i. Fire Alarm System: Red

ii. Sound/IC: Blue

iii. Telephone: Yellow

iv. Data: Green

v. MATV: Black

vi. Security: Orange

2. Identify Junction, Pull and Connection Boxes.

a. Code-required caution sign for boxes shall be pressured-sensitive, self-adhesive label indication system voltage in black, preprinted on orange background. Install on outside of box cover. Also label box covers on outside of cover with identity of contained circuits. Use pressure-sensitive plastic labels at exposed locations and similar labels or plasticized card stock tags at concealed boxes.

3. Label and paint the covers of the systems junction boxes as follows:

SYSTEM	COLOR (ALL COLORS ARE KWAL PAINT)	
Fire Alarm	Red Alert	AC118R
Sound/IC	Neon Blue	7076A
Telephone	Competition Yellow	7225A
Data	Java Green	AC098N
MATV	Flat Black	
Security	Fiesta Orange	AC107Y

E. Underground Electrical Line Identification.

1. During trench backfilling, for exterior underground power, signal, and communications lines, install continuous underground line detectable marking tape, located directly above line at 6 to 8 inches below finished grade. Where multiple lines are installed in a common trench or concrete envelope, do not exceed an overall width of 16 inches; install a single line marker.

2. Install detectable marking tape for underground wiring, both direct-buried and in raceway.

3. Provide red marker dye applied to concrete encased ductbank.

F. Conductor Color Coding.

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1. Provide color coding for secondary service, feeder and branch circuit conductors throughout the project secondary electrical system as follows:

208/120 Volts	Phase	480/277 Volts
Black	A	Brown
Red	B	Purple
Blue	C	Yellow
White	Neutral	Gray
Green	Ground	Green

2. Switch legs, travelers and other wiring for branch circuits shall be of colors other than those listed above.
3. Use conductors with color factory applied the entire length of the conductors except as follows:
   a. The following field-applied color-coding methods may be used in lieu of factory-coded wire for sizes larger than No. 10 AWG.
   b. Apply colored, pressure-sensitive plastic tape in half-lapped turns for a distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply the last two laps of tape with no tension to prevent possible unwinding. Use 1-inch-wide tape in colors as specified. Do not obliterate cable identification markings by taping. Tape locations may be adjusted slightly to prevent such obliteration.
   c. In lieu of pressure-sensitive tape, colored cable ties may be used for color identification. Apply three ties of specified color to each wire at each terminal or splice point starting 3 inches from the terminal and spaced 3 inches apart. Apply with a special tool or pliers, tighten for snug fit, and cut off excess length.

G. Power Circuit Identification.
1. Securely fasten identifying metal tags or aluminum wraparound marker bands to cables, feeders, and power circuits in vaults, pull boxes, junction boxes, manholes, and switchboard rooms with ¼-inch steel letter and number stamps with legend to correspond with designations on Drawings. If metal tags are provided, attach them with approximately 55-lb monofilament line or one-piece self-locking nylon cable ties.
2. Tag or label conductors as follows:
   a. Future Connections: Conductors indicated to be for future connection or connection under another contract with identification indicting source and circuit numbers.
   b. Multiple Circuits: Where multiple branch circuits or control wiring or communications/ signal conductors are present in the same box or enclosure (except for three-circuit, four-wire home runs), label each

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conductor or cable. Provide legend indicating source, voltage, circuit number, and phase for branch circuit wiring. Phase and voltage of branch circuit wiring may be indicated by mean of coded color of conductor insulation. For control and communications/signal wiring, use color coding or wire/cable marking tape at terminations and at intermediate locations where conductors appear in wiring boxes, troughs, and control cabinets. Use consistent letter/number conductor designations throughout on wire/cable marking tapes.

3. Match identification markings with designations used in panelboards shop drawings, Contract Documents, and similar previously established identification schemes for the facility's electrical installations.

H. Apply warning, caution and instruction signs and stencils as follows:

1. Install warning, caution, or instruction signs where required by NEC, where indicated, or where reasonably required to assure safe operation and maintenance of electrical systems and of the items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions or explanations are needed for system or equipment operation. Install butyrate signs with metal backing for outdoor items. Warning and caution signs shall be furnished and installed on, but not be limited to the following equipment and locations:

a. Entrances to rooms and other guarded locations that contain exposed live parts 600 volts or less; signs shall forbid unqualified personnel to enter.

b. Switch and Overcurrent device enclosures with splices, taps and feed-through conductors. Provide warning label on the enclosures that identifies the nearest disconnecting means for any feed-through conductors.

c. Entrances to buildings, vaults, rooms or enclosures containing exposed live parts or exposed conductors operating at over 600 volts: DANGER-HIGH VOLTAGE-KEEP OUT.

d. Metal-enclosed switchgear, unit substations, transformers, enclosures, pull boxes, connection boxes and similar equipment operating at over 600 volts shall have appropriate caution signs and warning labels.

e. Indoor and Outdoor substations operating over 600 volts. Provide warning signs, instructional signs and single-line diagrams in accordance with NEC 225.70.

I. Emergency Operating Signs: Install engraved laminated signs with white legend on red background with minimum 3/8-inch high lettering for emergency instructions on power transfer, load shedding, or other emergency operations.

J. Install equipment/system circuit/device identification as follows:

1. Apply equipment identification labels of engraved plastic-laminate on each major unit of electrical equipment in building, including central or master unit of each

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electrical system. This includes communication/signal/alarm systems, unless unit is specified with its own self-explanatory identification. Except as otherwise indicated, provide single line of text, with ¼-inch-high lettering on 1-inch-high label (1 ½-inch-high where two lines are required) white lettering in black field. White lettering in red field for Emergency Power Systems. Text shall match terminology and numbering of the Contract Documents and shop drawings. Apply labels for each unit of the following categories of electrical equipment.

a. Each service disconnect, to identify it as a service disconnect.

b. Panelboards (exterior and interior), electrical cabinets, and enclosures.For subpanels, identify feeder circuit from which served.

c. Switches in fusible panelboards shall be labeled. Main switches shall be identified.

d. Access doors and panels for concealed electrical items.

e. Electrical switchgear and switchboards.

f. Motor control centers.

g. Motor starters, including circuit origination, HP, heater size, FLA, and mechanical equipment designation.

h. Disconnect switches.

i. Pushbutton stations.

j. Power transfer equipment.

k. Contactors.

l. Dimmers.

m. Control devices.

n. Transformers.

o. Power generating units, to include transformer switches.

p. Telephone switching equipment.

q. TV/audio monitoring master station.

r. Fire alarm master station or control panel.

s. Variable frequency drives.

t. Lighting Control Equipment.

K. Post Conductor-Identification-Means labels at locations of switchboards, distribution panels and branch circuit panels. The labels shall identify the color-coding used on ungrounded conductors for each voltage system used on the premises.

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L. Apply Available-Fault-Current labels at the service entrance equipment.

M. Apply Source-of-Supply labels on the exterior covers of equipment (except in single- or two-family dwellings) as follows:

1. Each switchboard supplied by a feeder.
2. Each branch circuit panelboard supplied by a feeder.
3. Each disconnect switch serving elevators, escalators, moving walks, chairlifts, platform lifts and dumbwaiters.
4. Each dry type transformer (or primary-side disconnect switch at transformer). If the primary-side disconnect is remote from the transformer, both the remote disconnect and the transformer shall be labeled, and the transformer label shall also indicate the location of the disconnect.
5. Each feeder disconnect, branch circuit disconnect, panelboard or switchboard in a remote building or structure.

N. The label shall identify the device or equipment where the power supply originates, and the system voltage and phase. For example: Feeder Power Supply for Panel “XX” Originates at Panel “XX” (or Switchboard “XX”, Transformer “XX”, Switch “XX”, etc); 120/208 volts, 3-phase (or 120/240, 277/480, etc).

O. Install Arc-flash hazard labels on the following equipment:

1. Each piece of service entrance equipment.
2. Each power distribution switchboard or panel.
3. Each individually mounted circuit breaker.
4. Each branch circuit panelboard.
5. Each motor control center.
6. Each individually mounted motor starter.
7. Each meter socket enclosure.

P. Apply circuit/control/item designation labels of engraved plastic laminate for disconnect switches, breakers, pushbuttons, pilot lights, motor control centers, and similar items for power distribution and control components above, except panelboards and alarm/signal components, where labeling is specified elsewhere.

Q. Install labels at locations indicated and at locations for best convenience of viewing without interference with operation and maintenance of equipment.

R. Engrave all receptacle plates other than those serving 120 volt, single phase devices. State voltage and amperage characteristics: Example; “208V 30A”.

S. Mark each device box (for each type of wiring device) with a permanent ink felt tip marker, indicating the circuit to which the device is connected: Example; “CKT A-1”

T. Label circuit breaker feeding fire alarm panel “Fire Alarm Circuit”. Using plastic

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laminate label, white lettering on a red background.

END OF SECTION 26 0553

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SECTION 26 0923 - OCCUPANCY SENSORS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. This section is a Division-26 Basic Materials and Methods section, and is part of each Division-26 section making reference to wiring devices specified herein.

1.2 DESCRIPTION OF WORK:

A. The extent of occupancy sensor work is indicated by drawings and schedules.

B. Types of occupancy sensors in this section include the following:

1. Ultrasonic Ceiling Sensors
2. Control Pack
3. Dual Technology Wall Switch
4. Dual Technology Ceiling Sensor w/ Control Pack
5. Power Strip with Personal Sensor

1.3 QUALITY ASSURANCE:

A. Comply with NEC and NEMA standards as applicable to construction and installation of occupancy sensors. Provide occupancy sensors which have been UL listed and labeled.

B. All sensors shall be capable of operating normally with electronic ballasts, PL lamp systems, motor loads and any other passive infrared or microwave systems.

1.4 SUBMITTALS:

A. PRODUCT DATA: Submit manufacturer's data on occupancy sensors, control modules, wiring diagrams, interconnection diagrams and any related accessories.

B. Submit scaled drawings with lighting fixtures shown clearly marked by manufacturer showing proper product, location and orientation of each sensor.

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PART 2 - PRODUCTS

2.1 MANUFACTURER: The manufacturer shall have a minimum of five years of experience in the sensor and lighting control industry. Sensors and related relays shall be compatible with the specific lighting types controlled. All sensors shall be of the same manufacturer, mixing brands of sensors is not acceptable.

A. DUAL TECHNOLOGY WALL SWITCH: Where units are indicated provide a sensor that meets the following minimum requirements:

1. Sensor shall utilize PIR (Passive Infrared) to turn on the lights and then PIR or US (Ultrasonic) technologies to keep lights on.
2. Sensor shall incorporate an inrush current limiter circuit to protect the relay contacts.
3. Sensor shall utilize single or dual dry relay contacts for control of the lighting loads. Contractor shall verify requirements in coordination with the drawings.
4. Sensor shall have a self-adjusting time delay, selectable 5, 15 and 30 minutes.
5. Sensor shall have automatic sensitivity adjustment and be microprocessor controlled.
6. Sensor shall have light level sensing 0 to 200 footcandles.
7. Sensor shall have a 180 degree field of view, coverage up to 800 square feet and shall detect 6 inches of hand movement towards the sensor up to 300 square feet; and body motion towards the sensor up to 1000 square feet.
8. Sensor shall be rated for 0 to 800 watts at 120VAC and 0 to 1200 watts at 277VAC.
9. Sensor shall be automatic on and shall have an automatic to off override switch on the unit. Switch shall be equipped with an air gap switch to disconnect power to the lighting load.
10. Sensor shall have real time motion indicator on the front of the unit.
11. Sensor shall mount to a single gang switch box.
12. Subject to compliance with the above requirements. Provide models of one of the following:

    a. Greengate ONW-D

B. ULTRASONIC (MICROPHONICS) CEILING SENSOR WITH DAYLIGHT CONTROL: Where units are indicated, provide a sensor that meets the following minimum requirements:

1. Sensor shall meet all requirements of Ultrasonic Ceiling Sensors.
2. Sensor shall incorporate a daylight control photocell to control the lighting based on available ambient light and occupancy.
3. Photocell shall be adjustable from 2 to 300 footcandles.

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4. Photocell shall have an adjustable dead band control from 10% to 400% to set the difference between lights on level and lights off level.
5. Adjustments shall be accessible on front of sensor.
6. Photocell control shall have a bi-colored LED on front of sensor to aid in adjusting lighting on\off levels.
7. Photocell control shall have an adjustable time delay from 2 seconds to 4 minutes to prevent lights from cycling during temporary interruptions of ambient light.
8. Switching priority shall be given to the occupancy sensor function when the space is vacant to turn the lighting off.
9. Daylight control shall override the sensor when the space is occupied to turn the lighting off if there is sufficient ambient light available and on when ambient light level drops.
10. Daylight control shall not be dependent on the sensor cycling the lighting off before photocell control will operate.
11. Daylight control sensor shall be able to be networked with other sensors.
12. Subject to compliance with the above requirements, provide models of one of the following:
    a. Hubbell-ATU/CRP Series
    b. Sensor Switch-CM9-P Series
    c. Wattstopper-DT Series
    d. Mytech-Omni US –RP Series
    e. Leviton – OSC UOW Series

C. DUAL TECHNOLOGY CEILING SENSOR: Where units are indicated, provide a sensor that meets the following minimum requirements:

1. Sensor shall incorporate ultrasonic (microphonics) and infrared technologies in a single unit.
2. Sensor shall be Class 2, low voltage; capable of mounting in the ceiling for maximum coverage.
3. Sensor shall use internal microprocessor for motion signal analysis and automatic self-adjustment.
4. Sensor shall have automatic self-adjustment algorithm which adjusts timer and sensitivity settings to maximize performance and minimize energy usage.
5. Sensor shall have manual time-out adjustment from 8 minutes to 32 minutes and automatic time out from 8 minutes to 100 minutes.
6. Sensor shall have test time-out setting of 8 seconds, with automatic return to 8 minutes after one hour if sensor is left in test mode.
7. Sensor’s microprocessor shall automatically extend timer by 1 hour in response to recognition to false off condition. After 5 hours, sensor reduces extended time

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by 30 minutes and continues to reduce by 30 minute increments over the next few days.

8. Sensor's microprocessor shall automatically reduce either PIR or ultrasonic sensitivity in response to false on condition.
9. Sensor microprocessor will automatically monitor PIR background threshold signal level and makes corresponding sensitivity adjustments automatically.
10. Sensor microprocessor algorithm shall incorporate automatic adaptation to continuous airflow.
11. For airflow which is so intense as to mask motion, sensor shall flash indicator LED code to indicate excessive airflow.
12. Sensor's microprocessor shall use a four week learning period and develop a circadian calendar.
13. An internal 24 hour 7 day clock establishes what periods the room is typically occupied, biasing sensor to keep lights on while normally occupied and off when normally unoccupied.
14. Sensor shall have selection settings for the following dual technology schemes:
    a. High Sensitivity and High Confidence (miser mode)
15. Sensor shall be available with either 180 degrees or 360 degrees coverage pattern.
16. Infrared lens shall have 360 degree field of view. Two types of lens shall be available, standard and extra dense.
17. Sensor shall have a variety of mask inserts for PIR coverage rejection to prevent false tripping.
18. Transducers shall be protected from tampering.
19. Sensor shall have manual adjustments for timer and sensitivities and override switches to force manual adjustment mode.
20. Sensor shall have adjustable sensitivity from 0% to 100% for both ultrasonic and infrared.
21. Controls shall be behind cover to resist tampering. All adjustments shall be accessible from the front of the sensor.
22. Sensor shall be available with a photocell adjustment from 20 to 3,000 Lux.
23. Sensor shall provide internal operating status and settings confirmation via LED motion lamp indicator.
24. Sensor shall have two (if 180 degree) or three (if 360 degree) real time LED motion indicators visible from the front of the unit: Red = infrared; green = ultrasonic.
25. Subject to compliance with the above requirements, provide models of one of the following:
    a. Hubbell-ATD Series
    b. Sensor Switch-CM-PDT Series

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c. Wattstopper-DT Series

d. Mytech-Omni-DT Series

e. Lithonia - LMTO Series

f. Leviton – OSC UOW Series

g. Greengate OMC – DT Series

D. 24 VDC POWER/CONTROL PACK: Where units are indicated, provide a power/control pack that meets the following minimum requirements:

1. Control module shall consist of a DC power supply and a dry contact relay for switching a lighting load.
2. Control module shall be available in versions to accept 120, and 277 VAC line voltages.
3. Output shall be 24VDC nominal, and shall be inherently safe, low voltage, limited power output (Class 2).
4. Output shall supply 100mA current, in addition to current consumed internally to operate internal relay.
5. Relay shall utilize normally open, silver alloy dry contacts, and shall be rated for a 20A ballast load at 120V and 277V.
6. Relay function shall not require more than 5 mA control current to operate.
7. Control module shall have line voltage wiring, consisting of input voltage and relay contact connections, exiting from one end, and low voltage DC connections, consisting of ground, power, and control wires, exiting from the other end.
8. Control module shall be sized to fit inside a standard 4” x 4” junction box.
9. Control module shall be equipped with a 1/2” EMT threaded male fitting on the line voltage end, such that it may be mounted to the outside of a junction box with the line voltage wiring internal to the box and the low voltage wiring external.
10. Control module shall be equipable with accessory 1/2” EMT threaded male fitting on the low voltage end, such that it may be mounted to the inside of a ballast cavity with the box and line voltage wiring internal to the cavity and the low voltage wiring external.
11. Slave module shall be available for switching additional circuits. Slave module has same construction and specifications as control module except without power supply function.
12. Subject to compliance with the above requirements, provide models of one of the following:

    a. Hubbell-CU Series

    b. Sensor Switch-PP-20 Series

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c. Wattstopper-BEP Series

d. Mytech-MP Series

e. Lithonia - LPCS Series

f. Greengate SP20-MV Series

g. Leviton – OSC/OSA Series

E. POWER STRIP WITH PERSONAL SENSOR

1. Power strip with personal sensor shall be provided in every private office and open office workstation shown in the documents.

2. Provide an 8 receptacle surge suppressor with an occupancy sensor that controls six of the eight receptacles.

3. The surge suppressor has a 5 year warranty.

a. Wattstoper Isolé IDP-3050.

b. Approved Equivalent

PART 3 – EXECUTION

3.1 INSTALLATION OF LIGHTING CONTROL EQUIPMENT:

A. Install occupancy lighting control system components and ancillary equipment as indicated, in accordance with equipment manufacturer's written instructions, and with recognized industry practices, to ensure that lighting control equipment complies with requirements.

B. Comply with requirements of NEC, and applicable portions of NECA's "Standard of Installation" pertaining to general electrical installation practices.

C. Coordinate with other electrical work, including raceways, and electrical boxes and fittings, as necessary to interface installation of lighting control equipment work with other work.

D. Contractor shall be on site as required, to adjust lighting control units for proper operation.

E. Mount the switchpack in a standard 4" junction box. Mount sensor to a standard 4” junction boxes. Refer to manufacturer supplied mounting instructions.

F. Provide 5 spare sensors for each type used on project.

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3.2 FIELD QUALITY CONTROL:

A. Upon completion of installation and after circuitry has been energized, demonstrate capability and compliance of system with requirements.

B. System start-up: Provide a factory authorized technician to verify the installation and test the system.

C. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.

D. Contractor shall visit the job site 3 months after the owner has taken occupancy and adjust any units not operating properly, otherwise remove and replace with new units.

3.3 MANUFACTURER AUTHORIZED PERSONNEL TRAINING:

A. Building Operating Personnel Training: Train Owner's building personnel in procedures for starting-up, testing and operating lighting control system equipment.

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SECTION 26 0943 - LIGHTING CONTROL EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 specification sections, apply to work of this section.

B. Division-26 Basic Materials and Methods sections apply to work specified in this section.

1.2 DESCRIPTION OF WORK:

A. Extent of lighting control equipment work is indicated by drawings and schedules, and is hereby defined to include, but not by way of limitation, lighting control panels, control stations and other user interface devices, wiring and ancillary equipment.

B. Type of lighting control equipment specified in this section includes the following:

1. Programmable Relay/Dimmer Panels
2. Over-ride switch stations
3. Pre-set dimming control stations
4. Daylighting Controls

C. Requirements are indicated elsewhere in these specifications for work including, but not limited to, raceways, and electrical boxes and fittings, required for installation of lighting control equipment; not work of this section.

1.3 QUALITY ASSURANCE:

A. Manufacturers: Firms regularly engaged in manufacture of lighting control equipment and ancillary equipment, of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years. To ensure a uniform installation and single responsibility, all switching and dimming equipment described herein shall be supplied by a single manufacturer.

B. Installer: Qualified with at least 3 years of successful installation experience on projects with lighting control equipment installation work similar to that required for project.

C. NEC Compliance: Comply with applicable portions of NEMA standards pertaining to types of electrical equipment enclosures.

D. Codes and Standards: Provide units, which meet the requirements of I.E.E.E. Std. #587-1980 and IEEE Std. 2000.1-1998.

E. Independent Testing Laboratory: Provide units which have been tested and listed under UL 916 Energy Management Equipment Standards.

1.4 SUBMITTALS:

A. Product Data: Manufacturer's published catalog data sheets for all equipment and components of lighting control system.

B. Shop Drawings: Submit detailed drawings and documentation of lighting control components and interconnection including, but not necessarily limited to:

1. Electronic Controllers.
2. Control Stations.
3. Photo Sensors.
4. One-line schematic diagram with wire type details.
5. Network wiring details.
6. Lighting control panel load schedule.
7. Input and output wiring details.
8. Accurately scaled equipment layouts, wires/cables routing and connections to control wiring and electrical power feeders.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. Manufacturer: Subject to compliance with requirements, provide lighting control equipment of one of the following:

1. Lutron
2. Wattstopper

2.2 SYSTEM DESCRIPTION:

A. The lighting control system shall provide seamless control and monitoring of all lighting included in the scope of work regardless of whether it is relay switched or dimmed.

B. Low voltage switches and photocells shall be mounted in the interior spaces. Low voltage wiring from the switches and sensors to the relay panel shall be Class 2 or Class 2P (plenum rated) as required by the National Electric Code (NEC) and local standards. Each low voltage wire shall be labeled with the relay number (1-48) at each switch or sensor. Use only properly color coded, stranded #20 AWG (or as required by manufacturer) wire. All relays and switches shall be tested after installation to confirm proper operation and the loads recorded on the directory card in each panel.

2.3 EQUIPMENT:

A. Enclosure: Shall be NEMA 1 rated, code gauge steel cabinet. Enclosures and contents shall be designed to operate in interior spaces with temperatures of 32° - 104° F (0° - 40°C) and, 0-90% non-condensing humidity. Enclosure shall be available with optional recessed mounting hardware. See drawings for mounting requirements and refer to schedules on drawings for sizes.

B. Interior: Bracket and circuit board back plane with pre-mounted relays. Interiors shall be sized to accept relays and will provide true on/off indication of relay status through leds mounted on the circuit boards. Each relay shall be capable of direct on/off control by a low voltage switch or occupancy sensor. Relays shall be momentary – pulsed mechanically latching contractors rated at 20 amps, 120-277 vac. They shall attach to the interior by a single plug-in connector.

C. Power Supply: The enclosure shall be supplied with multi-tapped transformer and shall not require specification of voltage for each control location. Provide dedicated power feed to each enclosure. Transformer shall be 24 vac secondary to include internal overcurrent protection with automatic reset and metal oxide varistor protection against power line spikes.

D. Cover: Provide surface cover with captive screws in hinged, lockable configuration. A wiring schedule directory card shall be affixed to the cover's back to allow identification of circuits/ relays/ loads controlled if the door is open or the cover is off. Schedules must be typed and related to final room names and numbers (not bid document room names and numbers), no exceptions.

E. System Controller: The system controller shall consist of the user interface panel (UIP) and system control electronics. The system controller shall plug-into the enclosure. Do not install system controller into the enclosure until after rough-in phase of installation is complete.

F. Indoor Controller:

1. Provide master on/off control of a relay group while still allowing individual relays to be overridden by their local switch.
2. Two independent switch input channels shall accept any 2 or 3 wire switch.
3. One master input to control all connected relays on on/off.
4. Occupied/ Unoccupied dry contact for interface to schedule control options for manual on/auto on, user-adjustable time delay for overrides and blink warn before off.

G. Outdoor Controller:

1. Works in combination with a single weatherproof photosensor to be powered via low voltage wiring from the panel.

2. Control unit provides occupied/ unoccupied dry contact for interface to schedule control, plus 3 separate intelligent outputs for on/off control of security, parking, and signage lighting. Each output shall;

   a. Have corresponding user-selectable foot candle set point with an additional selectable egress relay for parking.

   b. Is capable of driving up to 3 relays wired in parallel, or 1 smart input to another control unit.

   c. Is controlled using smart sceneries designed specifically for the three types of lighting.

H. Switches/Plates:

1. Provide specification grade standard, pilot or locator configuration momentary pushbutton type switches as shown on the plans for overriding the relays. Provide in color to match Wiring Devices (Section 262726).
2. Provide industrial grade non-pilot light toggle switches as shown on the plans for overriding the relays. Provide in color to match Wiring Devices (Section 262726).
3. Provide matched specification grade plates to match plates in Wiring Devices (Section 26 2726).

I. Photocells:

1. Provide a photocontrol point that consists of an architecturally compatible sensor mounted in the appropriate location for measuring the available daylighting. Each sensor will have a separate calibration module mounted in an enclosure in the electrical closet.
2. Control Unit shall allow for either direct control of up to three devices. These devices can be a relay, or any other device which allows control by a three wire momentary contact.
3. Control unit shall be switchable between four foot-candle measurement ranges (1- 10 FC, 10- 100 FC, 100- 1000 FC and 1000- 10,000 FC). Depending upon the sensor head and application.
4. Control unit shall have separate trip points for the high and low response settings. These settings shall be entered via dial switches. LED’s shall be provided to illustrate whether the sensor is below the ‘low’ setting, above the ‘high’ setting, or in the deadband range.
5. Control unit shall allow for a momentary contact device to override the photcell relays to either an on or off state.
6. Control unit shall employ a 3-minute time delay between switching outputs to avoid nuisance tripping. It shall be possible to disable the time delay to aid in initial setup and trouble shooting.

7. Sensor devices shall be available to match application. Each sensor shall employ photodiode technology to allow a linear response to daylight in its given foot-candle range.

J. Indoor Lighting – Provide a sensor with a Fresnel lens providing for a 60° cone shape response area. The unit shall work with a range between 10-100 foot-candles.

K. Low Voltage Wire:

1. All low voltage wiring shall be color coded to match the relays, switches and sensors. Wire shall be UL listed as conforming to Class 2 or Class 2P wire requirements.
2. Switch colors as follows:
   a. Red/Black/White
   b. Red/Black/White/Yellow (Pilot)
   c. Red/Black/White/Blue (Locator)

L. Dimmer Modules:

1. Provide dimmer modules that mount to steel back plate, allowing module to be installed in enclosure. All module electronics and power device elements shall be mounted to a removable sub-assembly and shall be replaced without removal of the dimmer module.
2. Dimmer modules shall provide the following input/output features:
   a. Six universal dimmers with output terminal blocks.
   b. Six air-gap relays with output terminal blocks.
   c. Two low voltage switch inputs, configurable for raise/lower or on/off operation.
   d. Three 0-10V analog inputs.
   e. Two 24 V DC accessory power terminals for connection of photocell or occupancy sensors.
   f. One service override switch.
   g. One pair of remove override terminals.
3. The system shall provide status of all outputs via LED indicators.
4. Air gap relays associated with each dimmer shall provide positive off operation when dimmer intensity is set to zero. Separate output terminals for relays and dimmers shall accommodate loads requiring independent switched and dimmed control.
5. Dimmers shall be ‘Universal’ type rated for use with incandescent, low voltage, neon, cold cathode and fluorescent lamps. Digital firing circuits shall ensure that

all dimmers set to the same intensity will track together, no adjustments shall be required to ensure this operation.

6. Dimmers shall employ toroidal filters to reduce RFI and lamp filament noise.
7. Dimmer response curve shall be selectable via the UIP on the system controller and shall provide a means to optimize the dimmer response to control for each lamp type being controlled.
8. It shall be possible to independently set high end and low end trim points for each dimmer via the UIP on the system controller.
9. Each dimmer module shall provide two (2) dry contact inputs for override purposes.
10. Service override switch shall provide on/auto/off service override to control all relay outputs on the module.
11. One set of terminals on each dimmer module shall provide a means to force all dimmers to full output from an external source.

PART 3 - EXECUTION:

3.1 INSTALLATION OF LIGHTING CONTROL EQUIPMENT:

A. Install lighting control system components and ancillary equipment as indicated, in accordance with equipment manufacturers written instructions, and with recognized industry practices, to ensure that lighting control equipment complies with requirements.

B. Comply with Requirements of NEC, and applicable portions of NECA's 'Standard of Installation' pertaining to general electrical installation practices.

C. Coordinate with other electrical work, including raceways, electrical boxes and fittings, as necessary to interface installation of lighting control equipment work with other work.

D. Electrical Identification: Refer to Section 260553 for requirements.

3.2 FIELD QUALITY CONTROL:

A. Upon completion of installation and after circuitry has been energized, demonstrate capability and compliance of system with requirements.

B. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.

3.3 PRODUCT SUPPORT AND SERVICES:

A. System Start-Up: Provide a factory authorized technician to verify the installation, test the system, and train the owner on proper operation and maintenance of the system. Before requesting start-up services, the installing contractor shall verify that:

1. The control system has been fully installed in accordance with manufacturer's installation instructions.
2. Low voltage wiring for overrides and sensors in completed.
3. Accurate 'as-built' load schedules have been prepared for each lighting control panel.
4. Proper notification of the impending start-up has been provided to the owner's representative.

B. Factory support: Factory telephone support shall be available at no cost to the owner during the warranty period. Factory assistance shall consist of assistance in solving programming or other application issues pertaining to the control equipment. The factory shall provide a toll free number for technical support.

3.4 WARRANTY:

A. Manufacturer shall provide a one (1) year limited warranty on lighting control system. A ten (10) year limited warranty shall be provided on the lighting control relays.

3.5 AS-BUILT DRAWINGS:

A. A complete set of 'as-builts' drawings showing installed wiring, specific interconnections between all equipment, and internal wiring of this equipment shall be included in the operating and maintenance manuals upon complete of the system.

B. Provide a CD to the owner containing the information specified below. The CD shall include all information required to allow the Owner to change the schedules themselves. The CD shall contain a minimum of following:

1. CAD drawing files of 'as-built' lighting control components and point to point connections.
2. General configuration programming.
3. Job specific configuration programming to include schedule.
4. Tutorial file on complete programming of lighting control system.

END OF SECTION 26 0943

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SECTION 26 2200 - TRANSFORMERS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. Division-26 Basic Materials and Methods sections apply to work specified in this section.

1.2 DESCRIPTION OF WORK:

A. Extent of transformer work is indicated by drawings and schedules. Work includes complete installation and electrical connections.

B. Types of transformers in this section include the following:

1. Dry-type Distribution Transformers

1.3 QUALITY ASSURANCE:

A. Comply with NEC as applicable to installation and construction of electrical power/distribution transformers; with applicable portions of NEMA Std. Pub. Nos. TR1 and TR27; and with applicable ANSI/IEEE standards pertaining to power/distribution transformers.

B. Comply with applicable portions of ANSI/UL 506; "Safety Standard for Specialty Transformers". Provide distribution transformers which have been UL listed and labeled.

C. All characteristics, definitions, and terminology, except as specifically covered in this specification, shall be in accordance with the latest revision of the following ANSI/IEEE, NEMA, and Department of Energy standards.

1. C57.12.00 – IEEE Standard for Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.
2. C57.12.28 – Pad-Mounted Equipment - Enclosure Integrity.
3. C57.12.34 – IEEE Standard Requirements for Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers (2500 kVA and Smaller) - High Voltage: 34500GrdY/19920 Volts and Below; Low-Voltage: 480 Volt 2500 kVA and Smaller (issued in March 2005 - combines C57.12.22 and C57.12.26).
4. C57.12.90 – IEEE Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers and IEEE Guide for Short-Circuit Testing of Distribution and Power Transformers.

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5. C57.12.91 – Guide for Loading Mineral-Oil-Immersed Transformers.
6. NEMA TR 1-1993 (R2000) – Transformers, Regulators and Reactors, Table 0-2 Audible Sound Levels for Liquid-Immersed Power Transformers.
7. NEMA 260-1996 (2004) – Safety Labels for Pad-Mounted Switchgear and Transformers Sited in Public Areas.
8. 10 CFR Part 431 – Department of Energy – Energy Conservation Program for Commercial Equipment: Distribution Transformers Energy Conservation Standards; Final Rule.
9. NEMA ST-20 - Dry-Type Transformers for General Applications
10. NEMA TP-1-2002 – Standards for transformer energy efficiency.

1.4 SUBMITTALS:

A. PRODUCT DATA: Submit manufacturer's data on transformers, including certification of transformer performance efficiency, percentage regulation at 100 percent and 80 percent power factor, no-load and full load losses in watts, percent impedance at 75 degrees C, hot-spot and average temperature rise above 40 degrees C ambient, sound level in decibels, and standard published data. Before submitting product data, verify that dimensions of units to be supplied allow proper code required clearances adjacent to unit.

B. SHOP DRAWINGS: Submit dimensioned drawings of transformer installations, showing layout, mountings and supports, and spatial relationship to proximate walls and equipment.

C. MAINTENANCE STOCK FUSES: For types and ratings required, furnish additional fuses, amounting to one unit for every five installed units, but not less than three units of each (including ELSP fuses when specified).

PART 2 -PRODUCTS

2.1 DRY -TYPE DISTRIBUTION TRANSFORMERS:

A. GENERAL: Except as otherwise indicated, provide manufacturer's standard materials and components as indicated by published product information, designed and constructed as recommended by manufacturer, and as required for complete installation.

B. MANUFACTURER: Subject to compliance with requirements, provide products of one of the following (for each type of transformer):

1. Acme Transformer Company
2. General Electric Company
3. Cutler Hammer Products, Eaton Corp.
4. Federal Pacific
5. Hevi-Duty Electric Div., General Signal Corp.

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6. Jefferson Electric
7. Schneider Electric/Square D Co.
8. Hammond Power Solutions
9. Siemens Energy & Automation, Inc.

C. DRY-TYPE DISTRIBUTION TRANSFORMERS (GENERAL PURPOSE):

1. Provide factory-assembled, general-purpose, air-cooled, copper wound dry-type distribution transformers where shown; of sizes, characteristics, and rated capacities indicated. Provide primary winding with minimum of 4 full capacity taps; each 2-1/2 percent, two above and two below full-rated voltage for de-energized tap-changing operation.
2. Insulate with 220 degree C. UL recognized insulation system for 80° degree C rise above 40o ambient at full load.
3. Limit sound levels to the following (as determined by ANSI/NEMA standards):
   a. 30-50 KVA 42 dB
   b. 51-150 KVA 50 dB
   c. 151-300 KVA 52 dB
   d. 301-500 KVA 60 dB
   e. 501-1000 KVA 64 dB
4. Provide terminal enclosure, with cover, to accommodate primary and secondary coil wiring connections. Equip terminal leads with connectors installed, suitable for copper or aluminum wiring. Cushion-mount transformer with vibration isolation supports. Provide transformers with ventilated, heavy gauge sheet steel enclosures. Apply manufacturer's standard light gray indoor enamel over cleaned and phosphatized steel enclosure. Provide transformers suitable for wall and floor mounting as indicated.
5. The percent impedance voltage, as measured on the rated voltage connection, shall be per Table 2.

Table 2
Percent Impedance Voltage (Dry-Type)

KVA Rating (Secondary Voltage < 700 V)	Impedance
0 - 75	3.00 – 5.75%
112.5 - 225	4.00 - 5.75%
300 and above	5.00 - 5.75%

PART 3 – EXECUTION

3.1 INSTALLATION OF TRANSFORMERS

A. Install transformers as indicated, complying with manufacturer's written instructions,

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applicable requirements of NEC, NEMA and IEEE standards, and in accordance with recognized industry practices to ensure that products fulfill requirements.

B. Coordinate transformer installation work with electrical raceway and wire/cable work, as necessary for proper interface.

C. Connect transformer units to electrical wiring system; comply with requirements of other Division-26 sections.

D. MOUNTING: Provide concrete pad under all floor mounted equipment and equipment mounted at grade. Anchor transformer to pad with 3/8" expansion anchors at each corner of enclosure. Provide vertical and lateral support systems for all transformers which are supported from overhead structure. See drawings for support and attachment details. Provide neoprene vibration isolators at each anchor point.

E. GROUNDING: Provide tightly fastened equipment grounding and bonding connections for transformers.

F. TESTING: Upon completion of installation of transformers, energize primary circuit at rated voltage and frequency from normal power source and test transformers, including, but not limited to, audible sound levels, to demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at the site, then retest to demonstrate compliance; otherwise, remove and replace with new units and proceed with retesting.

END OF SECTION 26 2200

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SECTION 26 2413 - SWITCHGEAR AND SWITCHBOARDS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. Division-26 Basic Materials and methods sections apply to work of this section except as otherwise indicated. See Section 262713 Service Entrance, for metering requirements. See Section 264313 for SPD requirements.

1.2 DESCRIPTION OF WORK:

A. Extent of switchgear and switchboards is indicated by drawings and schedules.

B. Types of switchgear and switchboards in this section include the following:

1. AC Dead Front Switchboards (600V)

1.3 QUALITY ASSURANCE:

A. Comply with NEC as applicable to construction and installation of electrical switchgear and switchboards. Provide switchgear and switchboards which have been UL listed and labeled.

1.4 SUBMITTALS:

A. PRODUCT DATA: Submit manufacturer's data on switchgear and switchboards.

B. SHOP DRAWINGS: Submit dimensioned drawings of switchgear and switchboards showing accurately scaled basic sections including, but not necessarily limited to, auxiliary compartments, section components, and combination sections. Show plan view of equipment with dimensioned clearances to proximate equipment. Failure to submit said plan view shall not relieve contractor of responsibility to verify required clearances before release of equipment for fabrication.

C. MAINTENANCE STOCK FUSES: For types and ratings required, furnish additional fuses, amounting to one unit for every 5 installed units, but not less than 3 units of each.

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PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. Subject to compliance with requirements, provide products of one of the following (for each type of switchgear and switchboard):

B. AC DEAD FRONT SWITCHBOARDS (600V):

1. Cutler-Hammer Products, Eaton Corp.
2. General Electric Co.
3. Siemens Energy & Automation, Inc.
4. Square D Co.

2.2 EQUIPMENT SECTIONS AND COMPONENTS:

A. GENERAL: Except as otherwise indicated, provide switchgear and switchboards of types, sizes, characteristics, and ratings indicated, which comply with manufacturer's standard design, materials, components, and construction in accordance with published product information, and as required for a complete installation. See drawings and Section 262815. Series rated systems are not accepted.

B. Overcurrent Protection Devices, for main and branch devices. Provide switchgear, switchboards, and overcurrent devices of one manufacturer.

C. Provide each service entrance switchboard with surge protective device (SPD) mounted in a separate enclosure adjacent to the switchboard/switchgear. See Section 264313 for SPD unit requirements. Provide in-line fusing for each phase of the device, and wire in accordance with manufacturer's instructions, with conductor length not exceeding 18".

2.3 AC DEAD-FRONT SWITCHBOARDS (600V):

A. Provide factory assembled, dead front, metal enclosed, floor standing, self supporting, group mounted, secondary power switch boards, of sizes, electrical ratings and characteristics indicated consisting of panel (vertical) units, and containing circuit breaker and fusible switch assemblies of quantities, ratings and types indicated. Provide copper main bus and connections to switching devices of sufficient capacity to limit rated continuous current operating temperature rise to UL standard; with main bus and tap connections silver-surfaced or tin-plated and tightly bolted for maximum interrupting capacity. Provide accessibility of line and load terminations from front of switchboard. Prime and paint switchboard with manufacturer's standard finish and color. Equip units with built-in lifting eyes and yokes; provide individual panel (vertical) units, suitable for bolting together at project site, and constructed for the following environment:

1. Installation: Indoors, NEMA Type 1.

B. Limit height of upper most overcurrent device handle to 6'-2" to accommodate 4" curb.

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PART 3 - EXECUTION

3.1 INSTALLATION OF SWITCHGEAR AND SWITCHBOARDS:

A. Install switchgear and switchboards where shown, in accordance with manufacturer's written instructions with recognized industry practices to ensure that switchgear and switchboards comply with requirements of NEMA and NEC standards, and applicable portions of NECA's "Standard of Installation".

B. Install all switchgear and switchboards on 4" high concrete curb and bolt equipment to curb with 5/8" anchors at each corner and at intervals not to exceed 4 feet along perimeter. Install concrete wiring trench under switchgear and switchboards; 18" deep, and 4" smaller in length and width than equipment base. Install grounding bushings on conduits penetrating trench.

C. Arrange conductors within switchgear and switchboards in neat fashion, and secure with suitable ties.

D. Tighten fuses, if any, in each switchgear and switchboard.

E. Provide and install spare fuse cabinet in main electrical room.

F. Electrical Identification: Refer to Section 260553 for requirements.

3.2 ADJUST AND CLEAN:

A. Adjust operating mechanisms for free mechanical movement.

B. Touch-up scratched or marred surfaces to match original finish.

3.3 FIELD QUALITY CONTROL:

A. Prior to energization of switchgear and switchboards, check with ground resistance tester phase to phase and phase to ground insulation resistance levels to ensue requirements are fulfilled.

B. Prior to energization, check switchgear and switchboards for electrical continuity of circuits, and for short circuits.

C. Subsequent to wire and cable connections, energize switchgear and switchboard and demonstrate functioning in accordance with requirements.

END OF SECTION 26 2413

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SECTION 26 2416 - PANELBOARDS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. This section is a Division-26 Basic Materials and Methods section, and is part of each Division-26 section making reference to panelboards specified herein.

1.2 DESCRIPTION OF WORK:

A. The extent of panelboard and enclosure work, is indicated by drawings and schedules.

B. Types of panelboards and enclosures in this section include lighting and appliance panelboards, and power distribution panelboards.

1.3 QUALITY ASSURANCE:

A. Provide units which have been UL listed and labeled. Comply with NEC as applicable to installation of panelboards, cabinets, and cutout boxes. Comply with NEC pertaining to installation of wiring and equipment in hazardous locations. Comply with NEMA Stds. Pub No. 250, "Enclosures for Electrical Equipment (1000 volt maximum). Pub No. 1, "Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less".

1.4 SUBMITTALS:

A. PRODUCT DATA:

1. Submit manufacturer data including specifications, installation instructions and general recommendations, for each type of panelboard required.

B. SHOP DRAWINGS:

1. Submit dimensioned drawings of panelboards and enclosures showing accurately scaled layouts of enclosures and required individual panelboard devices, including but not necessarily limited to, circuit breakers, fusible switches, fuses, ground-fault circuit interrupters, and accessories.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

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

1. Cutler Hammer Products, Eaton Corp.
2. General Electric Company
3. Siemens Energy & Automation, Inc.
4. Square D Company

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2.2 PANELBOARDS:

A. GENERAL:

1. Except as otherwise indicated, provide panelboards, enclosures and ancillary components, of types, sizes, and ratings indicated. Equip with number of unit panelboard devices as required for complete installation. Fully equip "spaces" with hardware to receive breaker or switch of size indicated. Provide CU/AL rated lugs of proper size to accommodate conductors specified.

B. POWER DISTRIBUTION PANELBOARDS:

1. Provide dead-front safety type power distribution panelboards as indicated, with switching and protective devices in quantities, ratings, types and with arrangement shown. Equip with copper bus bars, full-sized neutral bus and ground bus. Provide fusible or circuit breaker branch and main devices as indicated. Series rated systems are not acceptable. See Section 262815, Overcurrent Protection Devices.

C. LIGHTING AND APPLIANCE PANELBOARDS:

1. Provide dead-front safety type lighting and appliance panelboards as indicated, with switching and protective devices in quantities, ratings, types, and arrangement shown. Provide bolt-on thermal magnetic type branch breakers. Where multiple breakers are indicated, provide with common trip handle. Series rated systems are not acceptable. Equip with copper bus bars, full-sized neutral bus, and ground bus.

D. PANELBOARD ENCLOSURES:

1. Provide galvanized sheet steel cabinet type enclosures, in sizes and NEMA types as indicated, code-gage minimum 16-gage thickness. Provide door-in-door hinged fronts. Provide fronts with adjustable indicating trim clamps, and doors with flush locks and keys, all panelboard enclosures keyed alike, with concealed door hinges and door swings as indicated. Equip with interior circuit-directory frame, and card with clear plastic covering. Provide baked gray enamel finish over a rust inhibitor. Provide enclosures fabricated by same manufacturer as overcurrent devices contained therein Bolt engraved plastic laminate labels indicating panel name and voltage on the interior and exterior of panelboards.

2. Provide floor to ceiling panel extensions for all surface mounted panels located outside of mechanical and electrical rooms.

E. FINISH:

1. Coat interior and exterior of surface with manufacturer's standard color; baked on enamel finish.

F. ELECTRICAL IDENTIFICATION:

1. Refer to Section 260553 for requirements.

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PART 3 – EXECUTION

3.1 INSTALLATION OF PANELBOARDS:

A. GENERAL:

1. Install panelboards and enclosures where indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation", in compliance with recognized industry practices to ensure products fulfill requirements.

B. MOUNTING:

1. Provide 4" high concrete curb under floor standing distribution panelboards.

2. Coordinate installation of panelboards and enclosures with cable and raceway installation work. Anchor enclosures firmly to walls and structural surfaces, ensuring they are permanently and mechanically secure. Arrange conductors neatly within enclosure, and secure with suitable nylon ties. Fill out panelboard's circuit directory card upon completion of installation work. Utilize actual final building room numbers, not architectural numbers used on drawings. Identify individual lighting circuits and individual receptacle circuits by room served. Label circuit breakers to identify location of subpanel or equipment supplied using room numbers and equipment names. Include room number with equipment circuit designations. All directories to be typewritten.

END OF SECTION 26 2416

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SECTION 26 2713 - SERVICE ENTRANCE

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. Division-26 Basic Materials and Methods sections apply to work specified in this section.

1.2 DESCRIPTION OF WORK:

A. Extent of service-entrance work is indicated by drawings and schedules.

B. Switchboards, panels, disconnects, transformers, etc., used for service-entrance equipment are specified in applicable Division-26 sections, and are included as work of this section.

C. Consult local utility relative to all costs for line extensions, connections, etc., and include all costs for bringing service to the facility in base bid. Confirm location of point of service before bidding.

D. Provide labor and materials as required to accomplish power company metering in accordance with power company standards and requirements.

E. Provide concrete pads of size and type required for service transformers. Verify location, size, openings, reinforcing requirements with local utility before beginning work. Comply with local utility and code required clearance requirements.

1.3 QUALITY ASSURANCE:

A. Comply with NEC and NEMA standards as applicable to construction and installation of service-entrance equipment and accessories. Provide service-entrance equipment and accessories which are UL-listed and labeled, and equipment marked, "Suitable for use as Service Equipment".

1.4 SUBMITTALS:

A. PRODUCT DATA: Submit manufacturer's data on service-entrance equipment and accessories.

B. SHOP DRAWINGS: Submit dimensioned layouts of service-entrance equipment and spatial relationships to proximate equipment. Failure to submit said layouts shall not relieve contractor of responsibility to verify required clearances before release of

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equipment to fabrication.

C. MAINTENANCE STOCK, FUSES: For types and ratings required, furnish additional fuses, amounting to one unit for every 2 installed units, but not less than one unit of each.

PART 2 – PRODUCTS

2.1 SERVICE - ENTRANCE EQUIPMENT:

A. GENERAL: Provide service-entrance equipment and accessories, of types, sizes, ratings and electrical characteristics indicated, which comply with manufacturer's standard materials, design and construction in accordance with published product information, and as required for complete installation, and as herein specified.

B. Provide each service entrance switchboard with Surge Protective Devices as required by Section 264313.

2.2 OVERCURRENT PROTECTIVE DEVICES:

A. GENERAL: Provide overcurrent protective devices complying with Division-26 section "Overcurrent Protective Devices", and as indicated on drawings.

2.3 METERING:

A. METER SOCKETS: Provide meter sockets which comply with requirements of local utility company supplying electrical power to service-entrance equipment of building project.

B. METERS: Provide meters, current and potential transformers, selector switches, wiring, etc. for a complete metering system. Provide meter of same manufacturer as switchboard (equal to Square D Power Logic Circuit Monitor, Class 3020, Model CM-3250), integrally mounted in service equipment, completely wired with control power input. Provide capability for metering the following data:

INSTANTANEOUS READINGS	DEMAND READINGS
RMS Current Values	Current Values
Phase A Current	Average Demand Current Phase A
Phase B Current	Average Demand Current Phase B
Phase C Current	Average Demand current Phase C
3-Phase Average Current	Peak Demand Current Phase A
Apparent RMS Current	Peak Demand Current Phase B
RMS Voltage Values	Peak Demand Current Phase C
Phase A-B Voltage	Real Power Values

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Phase B-C Voltage	Average Demand Real Power
Phase C-A Voltage	Predicted Demand Real Power
Phase A-N Voltage	Peak Demand Real Power
Phase B-N Voltage	Phase C-N Voltage
Power Factor Values	Energy Readings
Phase A Power Factor	-
Phase B Power Factor	Energy Accumulated
Phase C Power Factor	Reactive Energy Accumulated
3-Phase Total Power Factor	-
3-Phase Total Power Values	-
Real Power, 3-Phase Total	-
Reactive Power, 3-Phase Total	-
Apparent Power, 3-Phase Total	-
Frequency	-
Temperature	-

C. Provide with integral display, selection keys, and indicting LEDs. For each instantaneous reading, provide a running maximum and minimum history in non-volatile memory, capable of externally operated reset. Provide "waveform capture" feature to allow subsequent analysis of actual current and voltage profile for harmonic distortion.

2.4 RACEWAYS AND CONDUCTORS:

A. GENERAL: Provide raceways and conductors complying with applicable Division-26 Basic Materials and Methods sections.

B. WALL AND FLOOR SEALS: Provide wall and floor seals complying with Division-26 Basic Materials and Methods section "Raceways".

C. Fluidized thermal backfill (FTB): Provide fluidized thermal backfill (FTB) around service lateral conduits (Service Lateral: Conductors/conduits between RMP transformer and meter. See NEC Article 230) when there are seven or more conduits specified. FTB shall comply with requirements of Pacificorp material specification ZG071.

PART 3 – EXECUTION

3.1 INSTALLATION OF SERVICE-ENTRANCE EQUIPMENT:

A. Install service-entrance equipment as indicated, in accordance with manufacturer's written instructions, and with recognized industry practices, to ensure that service-entrance equipment fulfills requirements. Comply with applicable installation requirements of NEC and NEMA standards.

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B. Coordinate with other work, including utility company wiring, as necessary to interface installation of service-entrance equipment work with other work.

C. Install all floor standing service equipment on 4" high concrete curb and bolt equipment to curb with 3/8" anchors at each corner and at intervals not to exceed 8' along perimeter. Install concrete wiring trench under floor standing equipment; 12" deep, and 4" smaller in length and width than equipment base. Install grounding bushings on conduits penetrating trench.

3.2 GROUNDING:

A. Provide system and equipment grounding and bonding connections for service-entrance equipment and conductors, as required.

3.3 ADJUST AND CLEAN:

A. Adjust operating mechanisms for free mechanical movement.

B. Touch-up scratched or marred enclosure surfaces to match original finishes.

3.4 FIELD QUALITY CONTROL:

A. Upon completion of installation of service-entrance equipment and electrical circuitry, energize circuitry and demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.

END OF SECTION 26 2713

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SECTION 26 2726 - WIRING DEVICES

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. This section is a Division-26 Basic Materials and Methods section, and is part of each Division-26 section making reference to wiring devices specified herein.

1.2 DESCRIPTION OF WORK:

A. The extent of wiring device work is indicated by drawings and schedules. Wiring devices are defined as single discrete units of electrical distribution systems which are intended to carry but not utilize electric energy.

B. Types of electrical wiring devices in this section include the following:

1. Receptacles
2. Switches
3. Dimmer controls
4. Cord caps
5. Cord connectors

1.3 QUALITY ASSURANCE:

A. Comply with NEC and NEMA standards as applicable to construction and installation of electrical wiring devices. Provide electrical wiring devices which have been UL listed and labeled.

1.4 SUBMITTALS:

A. PRODUCT DATA:

1. Submit manufacturer's data on electrical wiring devices.

PART 2 - PRODUCTS

2.1 FABRICATED WIRING DEVICES:

A. GENERAL:

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1. Provide factory-fabricated wiring devices, in types, and electrical ratings for applications indicated and complying with NEMA Stds. Pub No. WD 1.

B. Provide wiring devices (of proper voltage rating) as follows:

	RECEPTACLE	SWITCHES			
MFGR		1-POLE	3-WAY	4-WAY	W-PILOT
Hubbell	HBL 5352	HBL 1221	HBL 1223	HBL 1224	HBL 1221-PL
Bryant	5352	1221	1223	1224	1221-PL
Pass Seymour	5352	20AC1	20AC3	20AC4	20AC1-RPL
Leviton	5362	1221	1223	1224	
Cooper	5352	1221	1273	1224	1221-PL

C. Provide devices in colors selected by Architect. Provide red devices on all emergency circuits.

D. TRANSIENT VOLTAGE SURGE SUPPRESSION (TVSS) RECEPTACLES:

1. Provide TVSS receptacles having 4 series parallel 130V MOV's capable of a minimum of 140 joules suppression. Provide units with visual (and audible) surge status indicators to monitor condition of surge circuit; visual indicator to be "on" when power present and suppression circuit is fully functional. (Audible indicator shall sound a "beep" alarm approximately every 30 seconds if suppression circuit has been damaged.) Provide NEMA 5-20R, 20 amp, 125V receptacle of one of the following manufacturers:

	MANUFACTURER	
SPECIFICATION GRADE	HUBBELL	PASS SEYMOUR
Duplex Recept-Visual only	5350	5352 XXXSP
Duplex Recept-Visual/Audible	5352	5362 XXXSP
Single Recept-Visual only	5351	N/A
Duplex Recept-Isol Gnd, Visual/Audible	IG5352S	IG5362 XXXSP
Single Recept-Isol Gnd, Visual only	IG5351S	N/A
HOSPITAL GRADE	HUBBELL	PASS SEYMOUR
Duplex Recept-Visual/Audible	8300HS	8300 XXXSP
Single Recept-Visual only	8310HS	N/A
Duplex Recept-Isol Gnd, Visual/Audible	IG8300HS	IG8300 XXXSP
Single Recept-Isol Gnd, Visual only	IG8310HS	N/A

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2. Color of devices selected by Architect. Provide red devices on all emergency circuits.

E. GROUND-FAULT INTERRUPTER:

1. Provide general-duty, duplex receptacle, ground-fault circuit interrupters; feed-thru types, capable of protecting connected downstream receptacles on single circuit; grounding type UL-rated Class A, Group A, 20-amperes rating; 120-volts, 60 Hz; with solid-state ground-fault sensing and signaling; with 5 milliamperes ground-fault trip level; color as selected by Architect. Provide Hospital grade where required elsewhere by specification or drawings. Provide units of one of the following:

a. P&S/Sierra

b. Hubbell

c. Leviton

d. Square D

F. TAMPER RESISTANT RECEPTACLES:

1. Provide tamper resistant receptacles in the following areas; Dwelling units, child care facilities, kindergarten and pre-school classrooms, guest rooms, guest suites and pediatric locations within healthcare facilities.

2. Provide products of one of the following:

a. Leviton-TWR20-X

b. Hubbell – BR20XTR

c. Pass Seymour – TR63X

d. Cooper – TR5362

G. WEATHER-RESISTANT RECEPTACLES

1. Provide weather-resistant receptacles in outdoor locations such as under roofed open porches, canopies, marquees, etc.

2. Provide products of one of the following:

a. Pass & Seymour 2095TRWRXXX.

b. Hubbell GFTR20XX

H. CORD CAPS AND CONNECTORS:

1. Provide 3, 4 and 5-wire grounding, cap plugs, and connectors of ampere and voltage rating required, for final equipment, and as indicated otherwise on drawings.

2. Provide products of one of the following:

a. Cooper

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b. General Electric

c. Hubbell

d. Leviton

e. P&S

I. INCANDESCENT LAMP DIMMERS:

1. Provide branch lighting solid-state AC dimmer controls for incandescent fixtures; wattage and voltage as indicated, 60 hertz, with continuously adjustable slider control. Dimmer shall match low voltage transformer. Color as selected by Architect. Provide devices manufactured by one of the following:

a. Lutron (Nova Series)

b. Hubbell (AS Series)

J. FLUORESCENT LAMP DIMMERS:

1. Provide single-pole, semi-conductor modular type AC dimmers for fluorescent fixtures; 60 hertz, with wattage and voltage as indicated, continuously adjustable slider control, and with electromagnetic filters to reduce noise and interference to minimum. Construct with continuously adjustable trim potentiometer for adjustment of low end dimming. Dimmer shall match lamp/ballast combination. Color as selected by Architect. Provide devices manufactured by one of the following:

a. Lutron (Nova Series)

2.2 WIRING DEVICE ACCESSORIES:

A. WALL PLATES:

1. Provide coverplates for wiring devices; plate color to match wiring devices to which attached. Provide nylon or stainless steel or Lexan coverplates in all finished areas as directed by Architect. Provide galvanized steel plates in unfinished areas. Provide blank coverplates for all empty outlet boxes.

B. WEATHER-PROTECTING DEVICE ENCLOSURES:

1. Where required for compliance with NEC 406-8 (receptacles installed outdoors for use other than with portable tools or equipment), provide weather-tight device covers which provide complete protection with the cord and cap inserted into the wiring device. Provide units which mount on either single or double gang devices.

2. Provide products of one of the following for In Box Horizontal for brick and cast stone:

a. Arlington Industries

i. DSHB1C Clear Cover

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ii. DSHB1W White Cover

iii. DSHB1BR Brown Cover

iv. DSHB1BRC Brown Clear Cover

3. Provide products of one of the following for In Box Vertical or Horizontal for Stucco and Metal Sidings:

a. Arlington Industries

i. DSBVM1C Clear Cover

ii. DSBVM1W White Cover

iii. DSBHM1C Clear Cover

iv. DSBHM1W White Cover

4. Provide products of one of the following for roof mounted installations:

a. Intermatic WP1020 or WP1030

b. P&S WIUC10C or WIUC20c

PART 3 – EXECUTION

3.1 GENERAL

A. Install wiring devices as indicated, in compliance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation" and in accordance with recognized industry practices to fulfill project requirements.

B. Coordinate with other work, including painting, electrical box and wiring work, as necessary to interface installation of wiring devices with other work. Install devices in boxes such that front of device is flush and square with coverplate. Drawings are small scale and, unless dimensioned, indicate approximate locations only of outlets, devices, equipment, etc. Locate outlets and apparatus symmetrically on floors, walls and ceilings where not dimensioned and coordinate with other work. Verify all dimensioned items on job site. Consult architectural cabinet, millwork, and equipment shop drawings before beginning rough-in of electrical work. Adjust locations of all electrical outlets as required to accommodate work in area, and to avoid conflicts with wainscoat, back splash, tackboards, and other items.

C. Install wiring devices only in electrical boxes which are clean; free from excess building materials, dirt, and debris.

D. Install blank plates on all boxes without devices.

E. Delay installation of wiring devices until wiring work and painting is completed. Provide separate neutral conductor from panel to each GFI receptacle.

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F. Install GFI receptacles for all receptacles installed in the following locations:

1. Restrooms, locker rooms, kitchens, within 6 feet of any sink, or when serving vending machines and electric drinking fountains.
2. Indoor wet locations, non-dwelling garages, elevator rooms and pits.
3. Outdoors, and on rooftops.
4. Dwelling unit garages, crawlspaces and unfinished basements, accessory buildings, boathouses, and receptacles for boat hoists.

G. Where light switches or wall box dimmers are specified, provide a separate neutral for each phase of the branch circuits to which switches or dimmers are connected.

H. Electrical Identification: Refer to Section 260553 for requirements.

3.2 PROTECTION OF WALL PLATES AND RECEPTACLES:

A. At time of substantial completion, replace those items, which have been damaged, including those stained, burned and scored.

3.3 GROUNDING:

A. Provide electrically continuous, tight grounding connections for wiring devices, unless otherwise indicated.

3.4 TESTING:

A. Prior to energizing circuitry, test wiring devices for electrical continuity and proper polarity connections. After energizing circuitry, test wiring devices to demonstrate compliance with requirements.

END OF SECTION 26 2726

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SECTION 26 2815 - OVERCURRENT PROTECTIVE DEVICES

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. This section is a Division-26 Basic Materials and Methods section, and is part of each Division-26 section making reference to overcurrent protective devices specified herein.

1.2 DESCRIPTION OF WORK:

A. Extent of overcurrent protective device work is indicated by drawings and schedules and specified herein. Overcurrent protective devices specified herein are for installation as individual components in separate enclosures; and for installation as integral components of switchboard and panelboards. See Section 262413, Switchgear and Switchboards, and Section 262416, Panelboards.

B. Types of overcurrent protective devices in this section include the following for operation at 600 Volts and below:

1. Molded case solid-state circuit breakers
2. Insulated case circuit breakers
3. Power circuit breakers
4. Fusible switches
5. Fuses

C. Refer to other Division-26 sections for cable/wire and connector work required in conjunction with overcurrent protective devices.

1.3 QUALITY ASSURANCE

A. Comply with NEC requirements and NEMA and ANSI standards as applicable to construction and installation of overcurrent devices.

1.4 SUBMITTALS:

A. PRODUCT DATA: Submit manufacturer's data on overcurrent protective devices, including catalog cuts, time-current trip characteristic curves, and mounting requirements.

B. SHOP DRAWINGS: Submit layout drawings of overcurrent protective devices, with

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layouts of circuit breakers, including spatial relationships to proximate equipment. Failure to submit said spatial layouts does not relieve contractor of responsibility to verify all required clearances before release of equipment for fabrication.

C. MAINTENANCE STOCK, FUSES: For types and ratings required, furnish additional fuses, amounting to one unit for every 5 installed units, but not less than two units of each size and type, unless specified otherwise in another section of these specifications.

D. TRIP CURVES & SETTINGS:

1. Submit time-current trip curves (in log-log format) and trip setting parameter/range information (for each trip function) for all solid-state circuit breakers.

a. Manufacturer shall also provide recommended trip settings with the shop drawing submittal (including ground fault settings) for coordination with downstream overcurrent devices. Manufacturer shall base recommendations on the AIC rating of the electrical equipment.

b. Where the Protective Device Study specification section 260573 is included in the project, the time-current curves and recommended trip settings for all solid-state circuit breakers shall be submitted as part of the protective device study.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. Subject to compliance with requirements, provide products of one of the following (main and branch device manufacturer must be same as panelboard and/or switchboard manufacturer):

B. CIRCUIT BREAKERS AND FUSIBLE SWITCHES:

1. Cutler Hammer Products, Eaton Corp.
2. General Electric Co.
3. Square D Co.
4. Siemens Energy and Automation

C. MOLDED CASE SOLID-STATE CIRCUIT BREAKERS:

1. Provide factory-assembled, molded case solid-state circuit breakers for power distribution switchgear and switchboards. Provide breakers of amperage, voltage and RMS interrupting rating shown, and with solid-state trip mechanisms. Breakers shall be UL listed for application at 100% of their continuous ampere rating.
2. Circuit breakers 800 amps through 1199 amps shall be molded case solid-state circuit breakers.

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3. Solid-state trip mechanisms shall have the following functions: Adjustable long time ampere rating; adjustable long time delay; adjustable short time pick up; adjustable short time delay and adjustable instantaneous pick up.

D. INSULATED CASE CIRCUIT BREAKERS

1. Provide factory-assembled, insulated case circuit breakers for power distribution switchgear and switchboards. Provide breakers of amperage, voltage and RMS interrupting rating shown, with solid-state trip mechanisms and with manual spring charging mechanism. Breakers shall be UL listed for application at 100% of their continuous ampere rating.
2. Circuit breakers 1200 amps and larger shall be insulated case circuit breakers.
3. Solid-state trip mechanisms shall have the following functions: Adjustable long time ampere rating; adjustable long time delay; adjustable short time pick up; adjustable short time delay and adjustable instantaneous pick up.
4. On service disconnect breakers where phase to ground voltage exceeds 150V and the breaker is capable of being set at or over 1000A (and also where GFP protection is indicated on the one line diagram for downstream breakers), the solid-state trip mechanism shall also include the following:
   a. Adjustable ground fault pick up and adjustable ground fault time delay, and ground fault test button.
   b. Over/under voltage trip
   c. Current imbalance trip
5. Include integral phase failure (single-phasing) protection where phase failure (PF) is indicated on the one line diagram

E. FUSIBLE SWITCHES:

1. Provide factory-assembled fusible switch units for power distribution panelboards and switchboards, and individual mounting as indicated. Provide switch units of amperage, voltage, and RMS interrupting rating as shown, with quick-make, quick-break mechanisms, visible blades and dual horsepower ratings. Series rated systems are not acceptable. Equip with lockable handles with on-off indication. Interlock switch covers and handles to prevent opening in "ON" position. Provide switch with Class R rejection fuse clip kits. Provide AL/CU rated lugs of proper size to accommodate conductors specified.

F. PHASE FAILURE PROTECTION:

1. Provide phase failure protection on overcurrent protective devices as indicated, by means of a single-phase, dead phase, reverse phase relay (Taylor Electronics Md1 PNDR). Provide relay to operate shunt trip or capacitor trip as required to open overcurrent protective device upon malfunction. Provide relay with adjustable time delay.

G. GROUND FAULT PROTECTION:

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1. Provide ground fault sensing and relaying equipment on all overcurrent protective devices where phase to ground voltage is in excess of 150 volts and the overcurrent protection device is capable of being set at or over 1000 amps. Provide ground fault sensing and relaying equipment on other devices as indicated.
2. Provide zero sequence current sensors for overcurrent protective devices; inputs compatible with relay. Construct sensor frame so it can be opened to prevent removal or installation around conductors without disturbing conductors. Provide test winding in sensor for testing operation of GFP unit including sensor pick-up relay, and circuit protection device operation.
3. Provide solid-state ground-fault relay, which requires no external source of electrical power, drawing energy to operate GFP system directly from output of current sensor. Construct with adjustable pick-up current sensitivity for GF current from 200 to 1200 amperes, with calibrated dial to show pick-up point settings. Provide factory-set time delay of 1.5 seconds and protection which precludes tampering with setting after installation.
4. Provide monitor panel capable of indicating relay operation, and provide means for testing system with or without interruption of service. Construct so GF system can not be left in an inactive or OFF state. Provide indicator lamps and TEST and RESET control switches.
5. MANUFACTURER: Subject to compliance with requirements, provide ground-fault sensing and relaying equipment of one of the following:
    a. General Electric Co.
    b. Brown Boveri Electric, Inc.
    c. HI-Z Corporation
    d. Pringle Electric Mfg. Co.
    e. Square D Co.

2.2 FUSES

A. GENERAL: Except as otherwise indicated, provided fuses of type, sizes and ratings and electrical characteristics of a single manufacturer as follows. Provide fuses labeled UL Class L or UL Class R, current limiting and rated for up to 200,000 amperes. Provide Buss KAZ signal activating fuses where required elsewhere in specification.

B. Where fuses are shown feeding individual or groups of equipment items, comply with manufacturer's recommendation for fusing; adjust fuse size and type as necessary to comply with manufacturer's recommendation.

C. Provide and install spare fuse cabinet in main electrical room.

D. MAIN SERVICE AND FEEDER CIRCUITS: For fuse ratings over 600 amperes provide

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UL Class L Fuses (KRP-C, or A4BQ or LCL or KLPC). For fuse ratings up to 600 amperes, provide UL Class RK1 (KTN-R, KTS-R or A2K-R, A6K-R or NCCR, SCLR or KLN-R, KLS-R). If fuse directly feeds motors, transformers or other inductive load provide UL RK5 time delay (FRN-R, FRS-R or TR-R, TRS-R or ECN-R, ECS-R or FLN-R, FLS-R).

E. BRANCH CIRCUITS: For motor circuits, transformer circuits, or other inductive loads, provide UL Class RK5 (FRN-R, FRS-R or TR-R, TRS-R or ECN-R, ECN-S or FLN-R, FLS-A). For other circuits, provide UL Class RK1, (KTN-R, KTS-R OR A2K-R, A6K-R or NCLR, SCLR OR KLNR, KLSR).

F. MANUFACTURER: Subject to compliance with requirements, provide fuses of one of the following:

1. Bussman Mfg. Co.
2. Mersen (Ferraz Shawmut)
3. Reliance Fuse Div./Brush Fuse Inc.
4. Littlefuse, Inc.

PART 3 – EXECUTION

3.1 INSTALLATION OF OVERCURRENT PROTECTIVE DEVICES:

A. Install overcurrent protective devices as indicated, in accordance with the manufacturer's written instructions and with recognized industry practices to ensure that protective devices comply with requirements. Comply with NEC and NEMA standards for installation of overcurrent protective devices.

B. Coordinate with work as necessary to interface installations of overcurrent protective devices with other work.

C. Install fuses in overcurrent protective devices. For motor circuits, fuse sizes shown on drawings are for general guidance only. Size fuses in accordance with fuse manufacturer's recommendation for given motor nameplate ampere rating. Test operation. If nuisance tripping occurs, increase fuse size and disconnect device (if necessary) as required to provide nuisance free tripping. Adjust fuse size properly for ambient temperature, frequent starting and stopping of motor loads, and for loads with long start times. Include all costs in bid.

D. After the switchgear is energized and just prior to Substantial Completion, the contractor shall ensure that the field-adjustable circuit breakers and solid-state circuit breakers and associated trip mechanisms have been set to the appropriate settings as recommended by the equipment Manufacturer (or as recommended by the electrical contractor's Protective Device Study if section 260573 has been included in the project). Time-current trip curves and trip setting information as was required in the Submittal portion of this specification shall be made available by the contractor at this time.

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E. Field test all ground fault protective devices for proper operation; test to be performed by representative of the manufacturer. Include verification of complete time current trip characteristics.

F. Electrical Identification: Refer to Section 260553 for requirements.

3.2 FIELD QUALITY CONTROL

A. Prior to energization of overcurrent protective devices, test devices for continuity of circuitry and for short-circuits. Correct malfunctioning units, and then demonstrate compliance with requirements.

PART 4 – SHORT CIRCUIT CALCULATIONS (FOR REFERENCE ONLY)

4.1

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Short-Circuit Evaluation

1 - Is the avai INPUT XFMR KVA — ○ YES ◉ NO

INPUT XFMR Z% — 5 Z%

2 - Select voltage and phase of system? — 480/277V 3-phase

DISTIRBUTION PANELBOARD

PANEL	600A MAIN BREAKER

XFMR kVA	500	kVA	
V(L-L)	480	Volts	
I_{fla}	601	Amps	
XFMR Z%	5.00	%	
I_{sca}	12,028	Amps	
Length of conductor	L	10	ft
Maximum Fault Current	I_{sca}	12,028	Amps
Number of conductors / phase	n	2	
Phase Conductor constant	C	24,297	
Line Voltage	V(L-L)	480	Volts
Neutral Conductor constant	C	24,297	
Line-to-neutral voltage	V(L-N)	277	Volts
f_{phase}		0.009	
$f_{neutral}$		0.018	
M_{phase}		0.991	
$M_{neutral}$		0.982	
$I_{phase(L-G)}$		11,922	
$I_{neutral}$		11,817	

$$I_{fla} = \frac{kVA \times 1000}{V(L-L)}$$ XFMR FULL LOAD AMPS

$$I_{sca} = \frac{I_{fla} \times 100}{XFMR\ Z\%}$$ AVAILABLE FAULT CURRENT

$$f = \frac{1.732 \times L \times I_{sca}}{C \times n \times V(L-L)}$$ 'f' FACTOR

Note: Use 2 and V(L-N) for $f_{neutral}$

$$M = \frac{1}{1 + f}$$ MULTIPLIER

$I_{rms} = I_{sca} \times M$ Available fault current at equipment

$I_{rms} = I_{sca} \times M$ Available fault current at equipment

Raceway Type: Copper in non-metallic raceway

Phase Conductor: 400 kcm

Neutral Conductor: 400 kcm

BRANCH PANELS

Branch Panel Raceway Type: Copper in non-metallic raceway

Panel	CT CAN	600 MAIN BRKR	X	X	X	X	X	X	X	X
Length(ft)	5	360	0	0	0	0	0	0	0	0
n	2	2	0	0	0	2	0	0	0	0
Phase Cond	400 kcm	400 kcm	4/0	4/0	350 kcm	350 kcm	14	14	14	14
Neutr Cond	400 kcm	400 kcm	4/0	4/0	350 kcm	350 kcm	14	14	14	14
I_{sca} @ DP	11,922	11,922	11,922	11,922	11,922	11,922	11,922	11,922	11,922	11,922
C(phase)	24,297	24,297	16,673	16,673	22,737	22,737	389	389	389	389
V(L-L)	480	480	480	480	480	480	480	480	480	480
C(neutral)	24,297	24,297	16,673	16,673	22,737	22,737	389	389	389	389
V(L-N)	277	277	277	277	277	277	277	277	277	277
f_{phase}	0.004	0.319	#DIV/0!	#DIV/0!	#DIV/0!	0.000	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
$f_{neutral}$	0.009	0.637	#DIV/0!	#DIV/0!	#DIV/0!	0.000	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
M_{phase}	0.996	0.758	#DIV/0!	#DIV/0!	#DIV/0!	1.000	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
$M_{neutral}$	0.991	0.611	#DIV/0!	#DIV/0!	#DIV/0!	1.000	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
$I_{phase(L-G)}$	11,869	9,041	#DIV/0!	#DIV/0!	#DIV/0!	11,922	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
$I_{neutral}$	11,817	7,281	#DIV/0!	#DIV/0!	#DIV/0!	11,922	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

Short-Circuit Evaluation

1 - Is the avai INPUT XFMR KVA — ○ YES ◉ NO

INPUT XFMR Z% — 5 Z%

2 - Select voltage and phase of system? — 208/120V 3-phase

DISTIRBUTION PANELBOARD

PANEL	MDP + Branch pnls

XFMR kVA	300	kVA	
V(L-L)	208	Volts	
I_{fla}	833	Amps	$I_{fla} = \frac{kVA \times 1000}{V(L-L)}$ XFMR FULL LOAD AMPS
XFMR Z%	5.00	%	
I_{sca}	16,654	Amps	$I_{sca} = \frac{I_{fla} \times 100}{XFMR\ Z\%}$ AVAILABLE FAULT CURRENT
Length of conductor	L	10	ft
Maximum Fault Current	I_{sca}	16,654	Amps
Number of conductors / phase	n	4	
Phase Conductor constant	C	19,704	
Line Voltage	V(L-L)	208	Volts
Neutral Conductor constant	C	19,704	
Line-to-neutral voltage	V(L-N)	120	Volts
f_{phase}		0.018	$f = \frac{1.732 \times L \times I_{sca}}{C \times n \times V(L-L)}$ 'f' FACTOR
$f_{neutral}$		0.035	Note: Use 2 and V(L-N) for $f_{neutral}$
M_{phase}		0.983	$M = \frac{1}{1 + f}$ MULTIPLIER
$M_{neutral}$		0.966	
$I_{phase(L-G)}$		16,366	$I_{rms} = I_{sca} \times M$ Available fault current at equipment
$I_{neutral}$		16,088	$I_{rms} = I_{sca} \times M$ Available fault current at equipment

Raceway Type: Copper in metallic raceway

Phase Conductor: 350 kcm

Neutral Conductor: 350 kcm

BRANCH PANELS

Branch Panel Raceway Type: Copper in metallic raceway

Panel	MDP	LP1	LP2	LP3	LP4	INV1	MP1			
Length(ft)	0	10	10	10	10	10	10			
n	4	1	1	1	1	1	1			
Phase Cond	350 kcm	1/0	1/0	4/0	1/0	8	4/0			
Neutr Cond	350 kcm	1/0	1/0	4/0	1/0	8	4/0			
Isca @ DP	16,366	16,366	16,366	16,366	16,366	16,366	16,366	16,366	16,366	16,366
C(phase)	19,704	8,925	8,925	15,082	8,925	1,557	15,082	#N/A	#N/A	#N/A
V(L-L)	208	208	208	208	208	208	208	208	208	208
C(neutral)	19,704	8,925	8,925	15,082	8,925	1,557	15,082	#N/A	#N/A	#N/A
V(L-N)	120	120	120	120	120	120	120	120	120	120
f_{phase}	0.000	0.153	0.153	0.090	0.153	0.875	0.090	#N/A	#N/A	#N/A
$f_{neutral}$	0.000	0.305	0.305	0.181	0.305	1.751	0.181	#N/A	#N/A	#N/A
M_{phase}	1.000	0.868	0.868	0.917	0.868	0.533	0.917	#N/A	#N/A	#N/A
$M_{neutral}$	1.000	0.766	0.766	0.847	0.766	0.364	0.847	#N/A	#N/A	#N/A
$I_{phase(L-G)}$	16,366	14,198	14,198	15,010	14,198	8,727	15,010	#N/A	#N/A	#N/A
$I_{neutral}$	16,366	12,537	12,537	13,861	12,537	5,950	13,861	#N/A	#N/A	#N/A

END OF SECTION 26 2815

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SECTION 26 2816 - MOTOR AND CIRCUIT DISCONNECTS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. This section is a Division-26 Basic Materials and Methods section, and is part of each Division-26 section making reference to motor and circuit disconnect switches specified herein.

1.2 DESCRIPTION OF WORK:

A. Extent of motor and circuit disconnect switch work is indicated by drawings and schedule. Work includes complete installations and electrical connections.

1.3 QUALITY ASSURANCE:

A. Provide motor and circuit disconnect switches which have been UL listed and labeled. Comply with applicable requirements of NEMA Standards Pub. No. KS 1, and NEC.

1.4 SUBMITTALS:

A. PRODUCT DATA: Submit manufacturer's data including specifications, installation and general recommendations, for each type of motor and circuit disconnect switch required.

B. SHOP DRAWINGS: Submit dimensioned drawings of electrical motor and circuit disconnect switches which have rating of 100 amperes and larger.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. MANUFACTURER: Subject to compliance with requirements, provide products of one of the following (for each type of switch):

1. Cutler Hammer Products, Eaton Corp.
2. Square D Company
3. General Electric Company
4. Siemens Energy & Automation, Inc.

2.2 FABRICATED SWITCHES:

A. GENERAL: Provide disconnect and safety switches as indicated herein. Provide:

1. General duty switches on 240 Volt rated circuits.
2. Heavy duty switches on 480 volt rated circuits.
3. HP rated switches on all motor circuits.

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B. GENERAL DUTY SWITCHES: Provide general-duty type, sheet-steel enclosed switches, fusible or non-fusible as indicated of types, sizes and electrical characteristics indicated; rated 240 volts, 60 hertz; incorporating spring assisted, quick-make, quick-break mechanisms. Provide single phase or three phase and with solid neutral as required by application. Equip with operating handle which is capable of being padlocked in OFF position. Provide NEMA 1 or NEMA 3R as required by application, unless noted. Provide fusible switches with Class R rejection fuse clip kits.

C. HEAVY-DUTY SWITCHES: Provide heavy-duty type, sheet-steel enclosed safety switches, fusible or non-fusible as indicated, of types, sizes and electrical characteristics indicated; rated 600 volts, 60 hertz; incorporating quick-make, quick-break type mechanisms. Provide single phase or 3 phase, and with solid neutral as required by application, Equip with operating handle which is capable of being padlocked in OFF position. Provide NEMA 1 or NEMA 3R as required by application unless noted. Provide fusible switches with Class R rejection fuse clip kits.

D. FUSES: Provide fuses for switches, as required of classes, types and ratings needed to fulfill electrical requirements for service indicated. Provide spare fuses amounting to one spare fuse for each 10 installed but not less than three of any one type and size. See Section 262815 Overcurrent Protective Devices for fuse types.

E. Electrical Identification: Refer to Section 260553 for requirements.

PART 3 - EXECUTION

3.1 INSTALLATION OF MOTOR AND CIRCUIT DISCONNECT SWITCHES:

A. Install motor and circuit disconnect switches where indicated, complying with manufacturer's written instructions, applicable requirements of NEC, NEMA, and NECA's "Standard of Installation" and in accordance with recognized industry practices to ensure that products fulfill requirements.

B. Coordinate motor and circuit disconnect switch installation work with electrical raceway and cable work, as necessary for proper interface.

C. Install disconnect switches used with motor driven appliances, and motors and controllers within sight of controller position.

D. For disconnect switches serving motors controlled by variable frequency drives, provide late-make, early-break auxiliary contacts on each disconnect switch. (Provide Heavy-Duty switch). Wire auxiliary contact to VFD safety contact, such that disconnecting the motor will shut down the drive first, and closing the switch will start the drive only after power is applied to the motor.

E. For disconnect switches serving elevators with auxiliary power hydraulic units, provide auxiliary contacts on each disconnect switch. Wire auxiliary contact to auxiliary power such that disconnecting the motor will disconnect the auxiliary power.

END OF SECTION 26 2816

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SECTION 26 2913 - MOTOR STARTERS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. This section is a Division-26 Basic Materials and Methods section, and is part of Division-26 sections making reference to motor starters specified herein.

1.2 DESCRIPTION OF WORK:

A. Extent of motor starter work is indicated by drawings and schedules.

B. Types of motor starters in this section include the following:

1. AC Fraction Horsepower Manual Starters
2. AC Line Voltage Manual Starters
3. AC Non-Reversing Magnetic Starters
4. AC Combination Non-Reversing Magnetic Starters

1.3 QUALITY ASSURANCE:

A. Comply with NEC and NEMA Standards as applicable to wiring methods, construction and installation of motor starters. Comply with applicable requirements of UL 508, "Electric Industrial Control Equipment", pertaining to electrical motor starters. Provide units which have been UL-listed and labeled.

1.4 SUBMITTALS:

A. PRODUCT DATA: Submit manufacturer's data on motor starters.

B. SHOP DRAWINGS: Submit dimensioned drawings of motor starters showing accurately scaled equipment layouts.

C. MOTOR VOLTAGE/CURRENT REPORT: After installation is complete, including water and air balancing, measure voltage (L-L and L-N) and full load current of each phase of each motor. Submit report showing field readings of voltage, amperage, service factor, and thermal heater size installed for each motor.

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PART 2 - PRODUCTS

2.1 MANUFACTURER:

A. Subject to compliance with requirements, provide products of one of the following (for each type and rating of motor starter):

1. Allen-Bradley Co.
2. Appleton Electric Co.
3. Crouse-Hinds Co.
4. Eaton Corp., Cutler Hammer Products
5. General Electric Co.
6. Siemens Energy & Automation, Inc.
7. Square D Co.

B. MAINTENANCE STOCK, FUSES: For types and ratings required, furnish additional fuses, amounting to one unit for every 10 installed units, but not less than 5 units of each, for both power and control circuit fuses.

2.2 MOTOR STARTERS:

A. GENERAL: Except as otherwise indicated, provide motor starters and ancillary components; of types, sizes, ratings and electrical characteristics indicated which comply with manufacturer's standard materials, design and construction in accordance with published information and as required for complete installations.

B. THERMAL OVERLOAD UNITS: Provide thermal overload units, sized to actual running full load current, not to motor plate current. Size heaters for mechanical equipment after air and water balancing have been completed.

C. AC FRACTIONAL HP MANUAL STARTERS (EQUAL TO SQUARE D CLASS 2510): Provide manual, single-phase, 1 and 2 pole, 300 volt AC max, fractional HP motor starters, of types, ratings and electrical characteristics indicated; equip with one piece thermal overload relay with field adjustment capability of plus or minus 10 percent of nominal overload heater rating; for protection of AC motors of 1 HP and less. (For manually controlled motors in excess of 1 HP, see Line Voltage Manual Starters specified herein). Provide starter with quick-make, quick-break trip free toggle mechanisms, green pilot lights, and with lock-off toggle operated handle. Mount surface units in NEMA 1 enclosures, unless noted otherwise. Provide NEMA 3R enclosure in exterior or damp location unless noted otherwise. Provide flush mounted units with coverplate to match wiring device coverplates.

D. AC LINE VOLTAGE MANUAL STARTERS (EQUAL TO SQUARE D CLASS 2510): Provide line voltage manual starters, of types, ratings and electrical characteristics indicated; 2 or 3 pole, 600 volt AC max; equip with pushbutton operator, low voltage

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protection feature, and green pilot light. Provide starters with trip free mechanism such that contacts will open under load and remain open until thermal element has cooled, and unit is reset. Mount surface units in NEMA 1 enclosure, unless noted otherwise. Provide NEMA 3R enclosure in exterior or damp location, unless noted otherwise. Provide overlapping trim for flush mounted units.

E. AC NON-REVERSING MAGNETIC STARTERS (EQUAL TO SQUARE D CLASS 8536): Provide line voltage magnetic starters, of types, ratings and electrical characteristics indicated; 2 or 3 pole, 600 volt max, with thermal overload protection in all phases and inherent under voltage release. Equip units with holding contact, 2 normally open, and 2 normally closed auxiliary contacts, unless noted otherwise. Provide fused control transformer in each starter and 120V control coil. Mount hand-off-auto switch, red pilot light, and reset button in face of enclosure. Provide NEMA 1 enclosure unless noted otherwise. Provide NEMA 3R enclosure in exterior or damp location, unless noted otherwise. Equip all spare starters complete with items as specified herein.

F. AC COMBINATION NON-REVERSING MAGNETIC STARTERS (EQUAL TO SQUARE D CLASS 8539): Provide line voltage combination starters, of types, ratings and electrical characteristics indicated; 2 or 3 pole, 600 volts max with non-reversing magnetic starters as specified herein; in common cubicle or enclosure with motor circuit protector. Provide motor circuit protector, instantaneous trip circuit breaker as indicated and adjust to comply with manufacturer's recommendations. Mount hand-off-auto switch, red pilot light, and reset button in face of enclosure. Provide combination starters for individual mounting, or for group mounting in motor control center as indicated. Provide NEMA 3R enclosure in exterior or damp locations, unless noted otherwise. Provide NEMA 1 enclosures unless otherwise indicated.

G. AC COMBINATION NON-REVERSING MAGNETIC STARTERS (EQUAL TO SQUARE D CLASS 8538): Provide line voltage combination starters, of types, ratings, and electrical characteristics; 2 or 3 pole, 600 volt maximum with non-reversing magnetic starters as specified herein; in common cubicle or enclosure with fusible disconnect switch. Provide quick-make, quick-break, disconnect for NEMA sizes 1, 2, 3, and 4; and visible blade, automatic circuit interrupters with push-to-trip feature and separate fuse clips for larger NEMA sizes. Fuse all starters with dual-element (time-delay) fuses equal to Bussman FRN/FRS-R. Equip disconnect switch with Class R rejection fuse kits. Mount hand-off-auto switch, red pilot light, and reset button in face of enclosure. Provide combination starters for individual mounting, or for group mounting in motor control centers as indicated. Provide NEMA 1 enclosures unless otherwise indicated. Provide NEMA 3R enclosure in exterior or damp locations, unless noted otherwise.

PART 3 - EXECUTION

3.1 INSTALLATION OF MOTOR STARTERS:

A. Install motor starters as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC, NEMA standards, and NECA's "Standards of

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Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.

B. Install fuses in fusible disconnects, if any. Mount chart inside each starter indicating heater type, size, and ampere ratings available.

C. Electrical Identification: Refer to Section 260553 for requirements.

3.2 ADJUST AND CLEAN:

A. Inspect operating mechanisms for malfunctioning and, where necessary, adjust units for free mechanical movement.

B. Touch-up scratched or marred surfaces to match original finish.

3.3 FIELD QUALITY CONTROL:

A. Subsequent to wire/cable hook-up, energize motor starters and demonstrate functioning of equipment in accordance with requirements.

END OF SECTION 26 2913

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SECTION 26 2923 - VARIABLE FREQUENCY DRIVES

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. Division-26 Basic Materials and Methods sections apply to work specified in this section.

1.2 DESCRIPTION OF WORK:

A. Provide variable frequency drive (VFD) and VFD systems work as indicated by drawings, schedules and as specified herein. Work includes complete installation, electrical connections, testing, and commissioning.

B. Verify compatibility of VFD with motors supplied under Division 23. Review Division 23 specifications, plans, schedules, etc., to ensure compatibility.

C. Provide harmonic control for all VFD systems. Provide AC line reactors for VFD systems serving motors less than 10 HP. Provide harmonic filters for VFD systems serving motors 10 HP and larger. Refer to paragraph 1.4.B.5 in the submittals portion of this specification for harmonic distortion limits.

1.3 QUALITY ASSURANCE:

A. Comply with NEC, NEMA and IEEE (including Harmonic Standard IEEE-519) Standards as applicable to wiring methods, construction and installation of variable frequency drives. Comply with applicable requirements of UL 508, "Power Conversion Equipment". Provide complete packaged units which have been UL-listed and labeled by Underwriters Laboratory or ETL Testing Laboratories, Inc. Note: The entire unit shall carry the label, not just components.

1.4 SUBMITTALS:

A. PRODUCT DATA: Submit manufacturer's data on variable frequency drives.

B. SHOP DRAWINGS: Submit dimensioned drawings of variable frequency drive systems including, but not necessarily limited to, the following:

1. Complete data sheet.
2. Set of outline drawings giving complete mounting information, conduit entry and exit dimensions, over all unit dimensions, weights, physical characteristics, etc.
3. Set of complete electrical drawings for power and control wiring.

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4. Manufacture's literature giving detailed information of equipment being supplied including parts numbers, model numbers and ratings.
5. Harmonic Distortion Limits: The VFD systems shall produce no more than 12% current THD and no more than 3% voltage THD throughout the normal operating range as measured at the input terminals of each VFD system, on motors 10 HP and larger, provide harmonic filters. For motors less than 10 HP provide AC line reactors with a minimum of 3% impedance. VFD supplier shall submit with the approval shop drawings their harmonic control scheme and actual test results for the proposed scheme on at least three of their existing installations. Data shall clearly identify what equipment is proposed and demonstrate that it routinely meets harmonic limits above for the applications similar to this project. Prior approvals also require this data.
6. Shop drawings shall include interior view of VFD system enclosures with all components identified and located.

C. HARMONIC DISTORTION REPORT: After installation is complete, submit harmonic voltage and current distortion report as specified herein.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. GENERAL: Subject to compliance with requirements, provide products manufactured by and supplied by one of the following vendors:

	VENDOR	VFD MANUFACTURER
1.	Energy Management Corporation	Mitsubishi
2.	Codale Electric Supply	Allen Bradley
3.	GE	GE/Fuji

B. VENDOR REQUIREMENTS: Vendors requesting approval by addendum must meet the following minimum requirements.

1. Must be actively engaged in manufacturing and supplying pulse width modulated variable frequency drives and built up systems, and must have a minimum of five years of experience in each supply or manufacture, as applicable.
2. Must maintain full time service personal on call 24 hours/day as well as authorized parts and service facilities within 250 miles of the project with demonstrated record of service for at least the last three years.
3. Must have UL 508C or ETL certification if project requires "built-up" assemblies which are not "factory-standard" products.
4. Must be an ISO-9001 certified facility; manufacturing all products to ISO-9001 quality standards.

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2.2 GENERAL:

A. Except as otherwise indicated, provide pulse width modulated variable frequency A.C. drives and ancillary components; of types, sizes, ratings and electrical characteristics indicated which comply with manufacturer's standard materials, design and construction in accordance with published information and as required for a complete installation.

2.3 APPLICATION:

A. Provide drive units which are applicable to the driven load characteristics. For centrifugal fan and pump applications, provide variable torque rated VFD's capable of providing 115% rated current for one minute. For conveyor, positive displacement pump and compressor applications, provide constant torque rated VFD's capable of providing 150% of rated current for one minute. In addition, provide drives which meet the following operating conditions:

1. Operable on facility power, with voltage and phase provided at building site, and without the need for isolation or step up/down transformers unless indicated.
2. Capable of performing at an altitude of 4500 feet above sea level and have an operating temperature range 0° to 40°C (32° to 104°F) with a relative humidity of 0 to 90% (non-condensing). If mounted outdoors or in unconditioned spaces, provide environmental control necessary to operate in climate of -20°C to 50°C (-4° to 122°F), 0 to 100% R.H.

2.4 VARIABLE FREQUENCY DRIVE SYSTEM:

A. The variable frequency AC drive shall convert 3 phase, 60 Hertz input power to an adjustable AC frequency and voltage for controlling the speed of AC squirrel cage motors. The rectifier section (converter) shall employ a diode or fully gated bridge to develop a constant DC bus voltage. Variable voltage rectifiers utilizing partially gated SCR's are unacceptable. The DC bus shall utilize filter capacitors and DC link inductors to minimize generated harmonics. The PWM inverter control scheme shall produce an output wave form which closely approximates actual sine wave current. The output voltage shall vary proportionally with the output frequency to maintain a constant volts/hertz value up to 60 Hz. The output voltage will remain constant above 60 Hz. The continuous current rating shall be equal to or greater than the full load amperes required by the application. Provide units capable of starting and continuously driving the specified maximum motor load as identified on drawings and schedules. Provide units with input filters and line reactors.

B. Provide system capable of operating without any system trip or damage based on the nominal power specifications and requirements indicated and subject to the following fluctuation:

1. Plus or minus 10% voltage fluctuation.
2. Plus or minus 3% frequency variation (5% if served by back-up generator)
3. Distorted voltage waveform with up to 10% total voltage harmonic distortion.

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4. Provide system with voltage sag ride-through coordination under normal operating (average load) conditions to prevent nuisance trips with the following utility interruptions (based on preliminary IEEE working group P1346 data):

   a. 0% voltage for 1 cycle.

   b. 60% voltage for 10 cycles.

   c. 87% voltage continuous.

C. The drive shall have sufficient capacity to provide speed control of the motor throughout the operating range as specified herein.

2.5 EFFICIENCY AND POWER FACTOR:

A. Provide solid state converter and inverter power switching components and controls to achieve a minimum 95% efficiency at full load and speed.

B. The displacement power factor (as measured at the input to the VFD system) shall be 95% or better across the operational speed range.

2.6 PROTECTION:

A. Provide short circuit protection by means of an externally operated, door interlocked circuit breaker or motor circuit protector (MCP) rated at 65,000 AIC minimum. Provide VFD's with fast acting semi-conductor fuses to protect against input short circuits. The door interlocked handle must be capable of being locked off to meet NEC requirements.

B. Provide VFD operated motor overload protection by means of programmable, speed sensitive, electronic overload circuits with instantaneous trip, inverse time trip and current limit functions. These shall be adjustable and optimized for the application. Comply with NEC requirements and UL 991. In the by-pass mode provide motor overload relay set to protect the motor and capable of starting across the line.

C. In addition to the protection above, provide over- and under-voltage protection, over-temperature protection, ground fault protection, and control or microprocessor fault protection. These protective circuits shall cause an orderly shutdown of the VFD, provide indication of the fault condition, and require a manual reset (except undervoltage) before restart. Undervoltage from a power loss shall be set to automatically restart after return to normal. The history of the previous three faults shall be retained in a fault buffer for later review.

2.7 CONSTRUCTION:

A. Provide NEMA configuration enclosure for each variable frequency drive system. The enclosure shall be either wall mounted or free standing, as required, with forced ventilation. Mount all components in a single enclosure including, but not limited to, the VFD unit, contactors, door interlocked circuit breaker, bypass/isolating equipment,

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and/or other items listed in the specification or shown on the drawings. All components shall be completely wired within the enclosure. Systems requiring mounting and interwiring of separate bypass enclosure are not acceptable. Limit overall size of unit to space allocated on the drawings. Verify code required clearance requirements before manufacture and installation of unit.

B. Indoor location: Provide NEMA 12 dust tight, non-ventilated enclosure, or NEMA 1 ventilated enclosure, ventilated by means of filtered air forced through the enclosure to create a positive internal pressure.

C. Outdoor location or location exposed to weather: Provide NEMA 4 (wash down type), non-ventilated, enclosure. Locate all external heat sinks, fans, etc. associated with heat transfer in the rear of the enclosure with adequate stand offs for proper convection.

D. Mount the variable frequency drive ancillary components on a removable panel within the enclosure such that panel is removable from enclosure for maintenance and part replacement.

E. Provide "Machine Tool" type control transformer with primary and secondary fusing. All control power for operator devices and customer connections shall be 120 volts.

F. Mount door with a minimum of two hinges with removable pins. Door shall be rigid and large doors shall have additional hinges and stiffening steel.

G. Provide door mounted, industrial type, oil tight operator devices similar to those found on motor control centers.

H. Paint enclosure with high grade epoxy (ANSI 61 Grey), a minimum of 50-70 microns thick.

I. Provide an electrical shock warning label to warn personnel that a potential of electric shock exists.

J. Provide screened or engraved labels on all door operator and pilot devices.

2.8 STANDARD FEATURES:

A. Provide the following standard features on all VFD units:

1. Motor Braking Torque shall be accomplished by means of DC injection into the motor or by regenerative braking.
2. The drive shall contain an output frequency clamp such that minimum or maximum output frequency can be set at desired limits.
3. Frequency Jump: The drive shall be supplied with frequency jump control to avoid operating at a point of resonance with the natural frequency of the machine.

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4. Synchronous Transfer: Provide synchronous transfer feature to allow transfer of motor from VFD to the utility line and back to VFD operation while the motor is running.

B. Provide the following door mounted operator controls as a minimum:

1. Hand/Off/Auto switch
2. VFD/Bypass selector switch
3. Local/Remote speed control
4. Frequency setting speed pot
5. Frequency indication meter calibrated in % speed.
6. Motor voltage indication
7. Motor current indication
8. VFD enable light
9. VFD fault light
10. VFD in Bypass light
11. External fault light (safeties interlock). If drive has an English character based display, this indication can be shown on that display in lieu of a pilot light.

C. Provide a minimum of the following protective features with an alarm display indication:

1. Instantaneous overcurrent
2. Motor stalled
3. Motor overload
4. Heatsink over temperature
5. Power loss
6. Output ground fault
7. Output short circuit
8. Loss of process speed signal (i.e. 4-20 ma.)
9. Microprocessor malfunction

D. Provide the following termination points on a terminal strip for field connection:

1. Safeties interlock connection
2. Remote Start/Stop connection
3. Remote VFD fault connection
4. Remote VFD/Bypass enable connection
5. Remote speed reference signal input (See item G below)

E. Provide the following parameter adjustments to tune the VFD system:

1. Minimum and maximum speeds; maximum output voltage at output frequency

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2. Acceleration and deceleration times (adjustable from 1 to 120 seconds, minimum)
3. Overcurrent trip point
4. Current limit response to overload
5. Adjustable carrier frequency to minimize audible motor noise.
6. DC boost to automatically (or manually, 3%) adjust boost voltage on each start to compensate for load changes.

F. The VFD shall be capable of starting into a rotating motor at any speed.

G. Remote signal connection terminals (0-5 VDC or 0-10 VDC = 0-100% speed or 4-20 ma = 20-100% Speed). Analog signals shall be programmable as normal or inverted.

H. The VFD shall have a programmable response to loss of a 4-20 ma signal. The following responses are acceptable.

1. Fault and stop the drive
2. Alarm and maintain last reference (within 10%)
3. Alarm and go to preset speed
4. Alarm and go to minimum speed
5. Alarm and go to maximum speed

I. The VFD shall have a programmable analog output rated either 0-20 ma or 0-5 volts to represent one of the following:

1. Proportional to output frequency
2. Proportional to output current
3. Proportional to DC bus voltage
4. Proportional to output power
5. A programmable output offset shall be provided to allow modification of the analog output to obtain 2-10 volt DC or 4-20 ma.

J. The VFD shall have output relay contacts rated 115 volt AC/30 volt DC 5 amp resistive, 2 amp inductive. The contacts shall be:

1. Form A run contact
2. Form C fault contact
3. Form C alarm contact
4. Form A programmable contact to change state upon the following conditions: at speed, at frequency, at current, or at torque

K. Main Disconnect: Provide a main disconnect MCP to disconnect the VFD system from incoming power.

L. Bypass/Isolation: Provide a contactor arrangement for manual bypass and isolation.

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1. Provide bypass contactor arrangement for transfer of the motor load to the incoming power for operation at constant speed.
2. Provide isolation contactor arrangement to disconnect the VFD output from the motor and disconnect the VFD input and harmonic controls from incoming power to allow maintenance on the VFD while operating in the bypass mode.
3. The bypass and isolation contactors shall be electrically and mechanically interlocked. Operation of the VFD/Bypass selector switch to the bypass mode shall disconnect the VFD and allow the motor to operate in the bypass mode.
4. Provide adjustable motor overload relays on the load (output) side of the VFD system.
5. All components shall be pre-wired in the same enclosure, and shall include the VFD, harmonic controls, contactors, main disconnect MCP, motor overload relays, VFD/Bypass selector switch, and VFD in Bypass light.

M. Harmonic Controls: Provide AC line reactors and/or harmonic filters as required to meet the harmonic distortion requirements specified in Submittals paragraph 1.4.B.5 of this specification.

N. Provide VFD with transient voltage surge suppression with maximum UL 1449 suppression rating of 1000 volts, line to ground on 480 volt systems, and 500 volts, line to ground on 208 volt systems.

2.9 TESTING:

A. Prior to shipping, test each unit and provide a certified test report with each unit. Standard tests shall include:

1. Visual inspection: Consisting of checking unit enclosure, wiring, connections, fasteners, covers and locking mechanism.
2. High pot test: Two (2)X rated voltage plus 1000 volts AC for 60 seconds shall be applied per UL 508 on all peripheral drive system power components (circuit breakers, contactors, motor overloads, line reactor, disconnect switches etc.) as a complete package. A copy of test results shall be included in operation manuals.
3. System run test under actual motor load.
4. Control panel devices: test all devices, lights, switches, etc.
5. Additional Equipment: test additional equipment specified with VFD system.
6. Special tests: as required and specified.

2.10 ELECTRICAL IDENTIFICATION:

A. Refer to Section 260553 for requirements.

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PART 3 – EXECUTION

3.1 MECHANICAL COORDINATION:

A. Meet with the supplier of the mechanical equipment and determine the exact characteristics of the motors for which VFD's are to be provided. Verify the exact control requirements, including interface signal type, reversing/non-reversing drives, interlocks, etc.

3.2 INSTALLATION OF VARIABLE FREQUENCY DRIVES:

A. Install variable frequency drives as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC, NEMA standards, and NECA's "Standards of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.

3.3 MOTOR DISCONNECT INTERLOCK:

A. Where motor disconnect switches are installed on the load side of VFD's, provide late-make, early-break auxiliary contacts on each disconnect switch. Wire auxiliary contact to VFD safety contact, such that disconnecting the motor will shut down the drive first, and closing the switch will start the drive only after power is applied to the motor.

3.4 ADJUST AND CLEAN:

A. Inspect operating mechanisms for malfunctioning and, where necessary, adjust units for free mechanical movement.

B. Touch-up scratched or marred surfaces to match original finish.

3.5 START-UP SERVICES:

A. The supplier of the AC drive described herein, shall provide field start-up service by an authorized factory trained service representative. The factory representative shall be trained in the maintenance and troubleshooting of the equipment as specified herein. Start-up service shall include system check-out, start-up and system run, and harmonic testing.

1. Verify that the input voltage is within the manufacturer's specification tolerances.
2. Verify that the motor rotation is correct in all modes of operation.
3. Verify all operator devices, programming and monitoring functions to be fully operational.
4. Verify operation of all field signal control connections.
5. Measure and record system output voltage and current at 50% and 100% speed. Tune the output voltage to correspond to motor nameplate data.

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6. Make all parameter adjustments to tune and optimize the VFD system to the application. Record all configuration values as part of this report.
7. Conduct harmonic tests as identified below.

B. Provide owner training for each model and type of VFD system provided.

3.6 HARMONIC DISTORTION REPORT:

A. After installation is complete, measure the harmonic voltage and current distortion of each Variable Frequency Drive system, with the VFD unit running at 50% operating speed and at highest operating speed. Take measurements on each phase (L-L and L-N) on the line side (input terminals) of the VFD.

B. Submit report which includes the following:

1. Data (text and graphical) showing voltage and current waveforms, voltage and current THD and individual harmonic spectrum analysis.
2. Power quality reports including telephone influence factor, true and displacement power factor, and voltage and current imbalance.

C. Provide the Engineer with two copies of the harmonic distortion report.

3.7 OPERATION AND MAINTENANCE MANUALS:

A. The vendor shall supply two complete manuals consisting of, as a minimum, general system arrangement, power wiring diagram, control wiring diagram, schematic of VFD System components and options, factory test reports, trouble shooting data, parts lists, and preventative maintenance information.

B. Prior to final acceptance, provide the engineer with two (2) copies of the harmonic distortion report. If the harmonics exceed the specified limits, VFD system will be rejected. The VFD vendor shall then have thirty (30) days to revise the harmonic control scheme and resubmit new shop drawings and new harmonic verification test reports for final acceptance. All costs resulting from non-compliance rejection, including additional engineer and contractor review time, will be paid by the VFD supplier.

END OF SECTION 26 2923

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SECTION 26 3213 - EMERGENCY ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. Division-26 Basic Materials and Methods sections apply to work specified in this section.

1.2 DESCRIPTION OF WORK:

A. Extent of emergency electrical system work is indicated by drawings and schedules.

B. Types of emergency system components specified in this section include the following:

1. Inverter Emergency Battery System

C. CONDUCTORS/CABLES, RACEWAYS, AND ELECTRICAL BOXES AND FITTINGS are specified in applicable Division-26 Basic Materials and Methods sections.

D. Refer to other Division-26 sections as applicable for work required in connection with emergency electrical systems.

1.3 QUALITY ASSURANCE:

A. Comply with NEC as applicable to wiring methods, materials, construction and installation of emergency electrical systems. Comply with applicable requirements of UL 924, "Emergency Lighting and Power Equipment" and UL 1008, "Automatic Transfer Switches". Provide system components, which are UL-listed and labeled.

B. Comply with applicable requirements of NFPA Nos. 37, (99), 101, and 110 pertaining to stationary combustion engines, (health care facilities), life safety code, and emergency and standby power supplies.

C. Comply with ANSI/NEMA Std. Pub. No. ICS 2, pertaining to AC automatic transfer switches. Comply with applicable requirements of ANSI/NEMA MG 1, "Motors and Generators", and MG 2, "Safety Standard for Construction and Guide for Selection, Installation and Use of Electric Motors and Generators". Comply with applicable portions of IEEE Std. 241, "IEEE Recommended Practice for Electric Power Systems in Commercial Buildings" pertaining to standby power.

1.4 SUBMITTALS:

A. SHOP DRAWINGS: Submit the following:

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1. Dimensioned drawings of emergency electrical system components and accessories including.
2. Manufacturer's standard catalog data describing inverter and all ancillary equipment in sufficient detail to demonstrate complete specification compliance.
3. Drawings depicting each of the following:
   a. Base mounted equipment, with base and all attachments including anchor bolt template and recommended clearances for maintenance and operation.
   b. Electric wiring of relays, breakers, and switches with applicable single line and wiring diagrams and written description of operation and the instrumentation provided.

B. Manufacturer's standard catalog data describing and depicting transfer along with all ancillary equipment in sufficient detail to demonstrate complete specification compliance. In addition provide the following:
1. One-line diagram of each switch assembly and wiring diagram of each unit.
2. A complete list of equipment and material to be provided, containing an adequate description of each separate item of equipment.

C. OPERATION AND MAINTENANCE MANUALS: Submit four complete sets of operating manuals for each item of equipment. Include the manufacturer's name, model number, and a description of all equipment, complete with basic operating features. Describe in detail all maintenance procedures and a troubleshooting guide listing possible breakdowns and repairs for each piece of equipment. Include all factory service manuals, complete parts lists, simplified schematic diagrams of each system as installed, and the originals from which all posted instructions were made. Include complete rest reports specified in Part 3-Execution herein.

PART 2 – PRODUCTS

2.1 GENERAL:

A. Provide emergency electrical systems and components, of types, ratings, and electrical characteristics indicated. Provide all system components thru one supplier to guarantee total system responsibility. Provide system and components capable of start and load transfer within 10 seconds of power outage.

2.2 ENVIRONMENTAL CONDITIONS:

A. Provide system components and accessories as required to ensure proper system operation.
1. Altitude: 4800 feet above sea level
2. Maximum ambient temperature: 50 degrees C.

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3. Minimum ambient temperature: 0 degrees C.
4. Seismic Zone as indicated in General Structural Notes.

2.1 INVERTER EMERGENCY BATTERY SYSTEM

A. Provide a solid state pulse width modulation (PWM) inverter producing pure sinusoidal output waveform with less than 3% maximum Total Harmonic Distortion (THD) for linear loads. Microprocessor and crystal controlled. Stand-by no break. PWM inverter type utilizing IGBT technology with 50ms transfer time. Microprocessor controlled, 2 x 20 character display with touch pad controls.

B. Electrical - 120V 1 phase 2 wire, 60 Hz +/- 3%. THD less than 10%, power factor 0.5 lag/lead.

C. Freestanding Nema 1 steel cabinet powder coated. Fully automatic, temperature compensated, microprocessor controlled charger recharges fuly dischared batteries in maximum 24 hours at nominal AC input voltage. AC input current limiting and over-voltage protection included.

D. Battery shall be maintenance free, sealed valve regulated, front terminals, 20 year life sealed lead calcium batteries. 90 minute standard discharge time at full load under normal operating temperature with low voltage disconnect protection.

E. Provide automatic programmable self tests of 5 minute monthly and 90 minute annual functions. Standard RS232 diagnostic interface.

F. Features
1. External Maintenance Bypass Switch
2. Summary Al arm Dry Contacts
3. Inverter On Dry Contacts
4. Bypass Relays
5. Auto Dialer
6. Seismic Mounting Kit
7. Diagnostic Interface

G. Approved Manufacturers
1. Emergi-Lite
2. Meyer

PART 3 – EXECUTION

3.1 INSTALLATION OF INVERTER EMERGENCY BATTERY SYSTEMS:

A. Install inverter as indicated, in accordance with the equipment manufacturer's written

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instructions, and with recognized industry practices, to ensure that inverter battery system fulfill requirements. Comply with NFPA and NEMA standards pertaining to installation.

B. Electrical Identification: Refer to Section 260553 for requirements.

3.2 GROUNDING:

A. Provide equipment grounding connections for system components.

3.3 TESTING:

A. Upon completion of installation of inverter and after building circuitry has been energized with normal power source, test inverter to demonstrate standby capability and compliance with requirements. Provide start-up and testing by factory authorized representative in accordance with manufacturer's recommendations.

3.4 ON SITE TRAINING:

A. Conduct a training course for operating staff as designated by the Owner. The training period shall consist of a total of 1 hour of normal working time.

3.5 SERVICE AND SUPPORT

A. The inverter shall be serviced by the local service organization (during the warranty period) that is trained and factory certified.

END OF SECTION 26 3213

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SECTION 26 3533 - POWER FACTOR CORRECTION

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. Division-26 Basic Materials and Methods sections apply to work specified in this section.

1.2 DESCRIPTION OF WORK:

A. Extent of power factor correction work is indicated by drawings and schedules. Work includes complete installation and electrical connections.

B. Types of power factor correction equipment in this section include the following:

1. Corrective capacitors

1.3 QUALITY ASSURANCE:

A. Comply with NEC as applicable to location and installation of power factor correction capacitors and ancillary equipment. Comply with requirements for ANSI/NEMA Std. Pub. No. ICS 2 pertaining to power factor correction capacitors. Comply with UL 810; "Capacitors". Provide power factor correction capacitors which are UL listed and labeled.

1.4 SUBMITTALS:

A. PRODUCT DATA: Submit manufacturer's data on power factor correction capacitors.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

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

1. General Electric Co.
2. Sprague Electric Co.

2.2 POWER FACTOR CORRECTION CAPACITORS:

A. GENERAL: Provide power factor correction capacitors and ancillary components; complying with manufacturer's standard materials, design and construction in accordance with published product information, and as required for a complete installation and as herein specified.

B. CAPACITORS: Provide factory-assembled power factor correction capacitors; of types, sizes, ratings, and electrical characteristics indicated. Construct of internally fused, individually replaceable, unit cells enclosed in protective enclosure. Provide capacitors with discharge resistors which reduce voltage to 50 volts or less within 1 minute after

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capacitors are disconnected. Construct single-case housings of welded heavy gage steel with capability of being ganged for multiple-bank installation, and equip with solderless connecting terminal lugs. Provide with non-flammable impregnant for operating over ambient temperature ranges of minus 40 degrees F (-40 degrees C) to 104 degrees F (40 degrees C).

C. MOUNTING: Mount capacitors in motor control centers or adjacent to motors as indicated. Provide all necessary bus work, connectors, frames, racks, etc., necessary for properly installed and secured capacitor.

PART 3 - EXECUTION

3.1 INSTALLATION OF POWER FACTOR CORRECTION CAPACITORS:

A. Install power factor correction capacitors as indicated, in accordance with the manufacturer's written instructions and with recognized industry practices to ensure that capacitors comply with requirements.

3.2 GROUNDING:

A. Provide tight equipment grounding connections for capacitors.

3.3 FIELD QUALITY CONTROL:

A. Subsequent to completion of installation of capacitors, energize capacitors and demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at the site, then retest to demonstrate compliance; otherwise, remove and replace with new units and proceed with retesting.

END OF SECTION 26 3533

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SECTION 26 4313 - SURGE PROTECTIVE DEVICES (SPD)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. Division 26 Basic Materials and Methods sections apply to work specified in this section.

1.2 DESCRIPTION OF WORK:

A. Extent of SPD's work is indicated by drawings, schedules and specified herein. Work includes complete installation, electrical connections, testing, and commissioning.

1.3 QUALITY ASSURANCE:

A. Comply with NEC, NEMA and IEEE Standards as applicable to wiring methods, construction and installation of SPD's. Comply with applicable requirements of ANSI/IEEE C62.11, C62.41.2 and C62.45; NFPA 70 285 (Type 2), 75, and 78; and ANSI/UL 1449 3rd edition. Provide complete packaged units that have been listed and labeled by Underwriters Laboratory. UL surge ratings (UL 1449) must be permanently affixed to the SPS's device.

1.4 SUBMITTALS:

A. PRODUCT DATA:

1. Submit manufacturer's data on SPD's listing all performance ratings specified or required herein.

B. SHOP DRAWINGS:

1. Submit dimensioned drawings of SPD's including, but not necessarily limited to, the following.

a. Complete data sheet.

b. Set of outline drawings giving complete mounting information, conduit entry and exit locations and dimensions, overall unit dimensions, weights, physical characteristics, etc.

c. Set of complete electrical drawings for power and control wiring.

d. Manufacturer's literature giving detailed information of equipment including parts numbers, model numbers and ratings.

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e. UL 1449 suppressed voltage rating documentation.

PART 2 - PRODUCTS:

2.1 ACCEPTABLE MANUFACTURERS:

A. Subject to compliance with requirements, provide products manufactured by one of the following as indicated by "Location Category" herein.

1. Advanced Protection Technologies Inc.
2. Current Technology Inc.
3. Cutler Hammer, Inc.
4. L.E.A. International
5. Emerson Network Power Surge Protection Inc.
6. United Power Corporation
7. GE
8. Eaton
9. Surgelogic (Square D)

2.2 GENERAL:

A. Except as otherwise indicated, provide high energy surge protective devices, with high frequency line noise filtering, suitable for application in Category A, B, and C environments as indicated. Provide types, sizes, ratings and electrical characteristics indicated that comply with manufacturer's standard materials, design, and construction in accordance with published information and as required for a complete installation.

2.3 VOLTAGE SURGE SUPPRESSION – GENERAL:

A. Electrical Requirements

1. Unit Operating Voltage – Refer to drawings for operating voltage and unit configuration.
2. Maximum Continuous Operating Voltage (MCOV) – The MCOV shall not be less than 115% of the nominal system operating voltage.
3. The suppression system shall incorporate thermally protected metal-oxide varistors (MOVs) as the core surge suppression component for the service entrance and all other distribution levels. The system shall not utilize silicon avalanche diodes, selenium cells, air gaps, or other components that may crowbar the system voltage leading to system upset or create any environmental hazards.
4. Protection Modes – The SPD must protect all modes of the electrical system being utilized. The required protection modes are indicated by bullets in the following table:

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	Protection Modes			
Configuration	L-N	L-G	L-L	N-G
Wye	●	●	●	●
Delta	N/A	●	●	N/A
Single Split Phase	●	●	●	●
High Leg Delta	●	●	●	●

5. Nominal Discharge Current (In) – All SPDs applied to the distribution system shall have a 20kA In rating regardless of their SPD Type (includes Types 1 and 2) or operating voltage. SPDs having an In less than 20kA shall be rejected.
6. ANSI/UL 1449 3rd Edition Voltage Protection Rating (VPR) – The maximum ANSI/UL 1449 3rd Edition VPR for the device shall not exceed the following:

B. SPD Design

1. Maintenance Free Design – The SPD shall be maintenance free and shall not require any user intervention throughout its life. SPDs containing items such as replaceable modules, replaceable fuses, or replaceable batteries shall not be accepted. SPDs requiring any maintenance of any sort such as periodic tightening of connections shall not be accepted. SPDs requiring user intervention to test the unit via a diagnostic test kit or similar device shall not be accepted.
2. Balanced Suppression Platform – The surge current shall be equally distributed to all MOV components to ensure equal stressing and maximum performance. The surge suppression platform must provide equal impedance paths to each matched MOV. Designs incorporating replaceable SPD modules shall not be accepted.
3. Electrical Noise Filter – Each unit shall include a high-performance EMI/RFI noise rejection filter. Noise attenuation for electric line noise shall be up to 50 dB from 10 kHz to 100 MHz using the MIL-STD-220A insertion loss test method. Products unable able to meet this specification shall not be accepted.
4. Internal Connections – No plug-in component modules or printed circuit boards shall be used as surge current conductors. All internal components shall be soldered, hardwired with connections utilizing low impedance conductors.
5. Monitoring Diagnostics – Each SPD shall provide the following integral monitoring options:

   a. Protection Status Indicators - Each unit shall have a green / red solid-state indicator light that reports the status of the protection on each phase.

      i. For wye configured units, the indicator lights must report the status of all protection elements and circuitry in the L-N and L-G modes. Wye configured units shall also contain an additional green / red solid-state

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indicator light that reports the status of the protection elements and circuitry in the N-G mode. SPDs that indicate only the status of the L-N and L-G modes shall not be accepted.

ii. For delta configured units, the indicator lights must report the status of all protection elements and circuitry in the L-G and L-L modes.

iii. The absence of a green light and the presence of a red light shall indicate that damage has occurred on the respective phase or mode. All protection status indicators must indicate the actual status of the protection on each phase or mode. If power is removed from any one phase, the indicator lights must continue to indicate the status of the protection on all other phases and protection modes. Diagnostics packages that simply indicate whether power is present on a particular phase shall not be accepted.

b. Remote Status Monitor – The SPD must include Form C dry contacts (one NO and one NC) for remote annunciation of its status. Both the NO and NC contacts shall change state under any fault condition.

c. Audible Alarm and Silence Button – The SPD shall contain an audible alarm that will be activated under any fault condition. There shall also be an audible alarm silence button used to silence the audible alarm after it has been activated.

d. Surge Counter – The SPD shall be equipped with an LCD display that indicates to the user how many surges have occurred at the location. The surge counter shall trigger each time a surge event with a peak current magnitude of a minimum of 50 ± 20A occurs. A reset pushbutton shall also be standard, allowing the surge counter to be zeroed. The reset button shall contain a mechanism to prevent accidental resetting of the counter via a single, short-duration button press. In order to prevent accidental resetting, the surge counter reset button shall be depressed for a minimum of 2 seconds in order to clear the surge count total.

i. The ongoing surge count shall be stored in non-volatile memory. If power to the SPD is completely interrupted, the ongoing count indicated on the surge counter's display prior to the interruption shall be stored in non-volatile memory and displayed after power is restored. The surge counter's memory shall not require a backup battery in order to achieve this functionality.

6. Overcurrent Protection

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a. The unit shall contain thermally protected MOVs. These thermally protected MOVs shall have a thermal protection element packaged together with the MOV in order to achieve overcurrent protection of the MOV. The thermal protection element shall disconnect the MOV(s) from the system in a fail-safe manner should a condition occur that would cause them to enter a thermal runaway condition.

7. Fully Integrated Component Design – All of the SPD's components and diagnostics shall be contained within one discrete assembly. SPDs or individual SPD modules that must be ganged together in order to achieve higher surge current ratings or other functionality shall not be accepted.

8. Safety Requirements

a. The SPD shall minimize potential arc flash hazards by containing no user serviceable / replaceable parts and shall be maintenance free. SPDs containing items such as replaceable modules, replaceable fuses, or replaceable batteries shall not be accepted. SPDs requiring any maintenance of any sort such as periodic tightening of connections shall not be accepted. SPDs requiring user intervention to test the unit via a diagnostic test kit or similar device shall not be accepted.

b. SPDs designed to interface with the electrical assembly via conductors shall require no user contact with the inside of the unit. Such units shall have any required conductors be factory installed.

c. Sidemount SPDs shall be factory sealed in order to prevent access to the inside of the unit. Sidemount SPDs shall have factory installed phase, neutral, ground and remote status contact conductors factory installed and shall have a pigtail of conductors protruding outside of the enclosure for field installation.

2.4 SYSTEM APPLICATION

A. The SPD applications covered under this section include distribution and branch panel locations, busway, motor control centers (MCC), switchgear, and switchboard assemblies. All SPDs shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category C, B, and A environments.

B. Surge Current Capacity – The minimum surge current capacity the device is capable of withstanding shall be as shown in the following table:

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Minimum surge current capacity based on ANSI / IEEE C62.41 location category			
CATEGORY	Application	Per Phase	Per Mode
C	Service Entrance Locations (Switchboards, Switchgear, MCC, Main Entrance)	250 kA	125 kA
B	High Exposure Roof Top Locations (Distribution Panelboards)	160 kA	80 kA
A	Branch Locations (Panelboards, MCCs, Busway)	120 kA	60 kA

C. SPD Type – all SPDs installed on the line side of the service entrance disconnect shall be Type 1 SPDs. All SPDs installed on the load side of the service entrance disconnect shall be Type 1 or Type 2 SPDs.

2.5 LIGHTING AND DISTRIBUTION PANELBOARD REQUIREMENTS

A. The SPD application covered under this section includes lighting and distribution panelboards. The SPD units shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category B environments.

1. The SPD shall not limit the use of through-feed lugs, sub-feed lugs, and sub-feed breaker options.
2. SPDs shall be installed immediately following the load side of the main breaker. SPDs installed in main lug only panelboards shall be installed immediately following the incoming main lugs.
3. The panelboard shall be capable of re-energizing upon removal of the SPD.
4. The SPD shall be interfaced to the panelboard via a direct bus bar connection. Alternately, an SPD connected to a 30A circuit breaker for disconnecting purposes may be installed using short lengths of conductors as long as the conductors originate integrally to the SPD. The SPD shall be located directly adjacent to the 30A circuit breaker.
5. The SPD shall be included and mounted within the panelboard by the manufacturer of the panelboard.
6. The SPD shall be of the same manufacturer as the panelboard.
7. The complete panelboard including the SPD shall be UL67 listed.

B. Sidemount Mounting Applications Installation (SPD mounted external to electrical assembly)

1. Lead length between the breaker and suppressor shall be kept as short as possible to ensure optimum performance. Any excess conductor length shall be trimmed in order to minimize let-through voltage. The installer shall comply with the manufacturer's recommended installation and wiring practices.

C. Switchgear, Switchboard, MCC and Busway Requirements

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1. The SPD application covered under this section is for switchgear, switchboard, MCC, and busway locations. Service entrance located SPDs shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category C environments.
2. The SPD shall be of the same manufacturer as the switchgear, switchboard, MCC, and busway
3. The SPD shall be factory installed inside the switchgear, switchboard, MCC, and/or bus plug at the assembly point by the original equipment manufacturer
4. Locate the SPD on the load side of the main disconnect device, as close as possible to the phase conductors and the ground/neutral bar.
5. The SPD shall be connected through a disconnect (30A circuit breaker). The disconnect shall be located in immediate proximity to the SPD. Connection shall be made via bus, conductors, or other connections originating in the SPD and shall be kept as short as possible.
6. The SPD shall be integral to switchgear, switchboard, MCC, and/or bus plug as a factory standardized design.
7. All monitoring and diagnostic features shall be visible from the front of the equipment.

2.6 ENCLOSURES

A. All enclosed equipment shall have NEMA 1 general purpose enclosures, unless otherwise noted. Provide enclosures suitable for locations as indicated on the drawings and as described below:

1. NEMA 1 – Constructed of a polymer (units integrated within electrical assemblies) or steel (sidemount units only), intended for indoor use to provide a degree of protection to personal access to hazardous parts and provide a degree of protection against the ingress of solid foreign objects (falling dirt).
2. NEMA 4 – Constructed of steel intended for either indoor or outdoor use to provide a degree of protection against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (dirt and windblown dust); to provide a degree of protection with respect to the harmful effects on the equipment due to the ingress of water (rain, sleet, snow, splashing water, and hose directed water); and that will be undamaged by the external formation of ice on the enclosure. (sidemount units only)
3. NEMA 4X – Constructed of stainless steel providing the same level of protection as the NEMA 4 enclosure with the addition of corrosion protection. (sidemount units only)

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PART 3 - EXECUTION

3.1 INSTALLATION

A. Install SPD's as indicated in accordance with manufacturers recommendations and as necessary to meet requirements. Install with conductors of minimum length practicable, but in no case exceeding 30" in length; minimum conductor size - #8 AWG copper.

B. Install conductors in straight runs with a minimum of turns or bends (minimum bend radius to be 90 degrees). Do not splice phase or ground conductors in SPD's circuit. Torque all conductor terminations in accordance with manufacturer's recommendations.

3.2 FIELD QUALITY CONTROL:

A. Upon completion of installation of equipment, energize and demonstrate capability and compliance with requirements. Remove malfunctioning units, replace with new units and proceed with retesting.

END OF SECTION 26 4313

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SECTION 26 5100 - INTERIOR AND EXTERIOR BUILDING LIGHTING

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. Division-26 Basic Materials and Methods sections apply to work specified in this section.

1.2 DESCRIPTION OF WORK:

A. Types of lighting fixtures in this section are indicated by schedule and include the following:

1. High-Intensity-Discharge (HID)
2. Fluorescent
3. Incandescent/Halogen
4. LED (Light Emitting Diode)

1.3 QUALITY ASSURANCE:

A. Comply with NEC, NEMA and ANSI 132,1 as applicable to installation and construction of lighting fixtures. Comply with NEC 410-65C for all recessed incandescent light fixtures. Provide lighting fixtures which have been UL-listed and labeled.

1.4 SUBMITTALS:

A. PRODUCT DATA:

1. Submit manufacturer's data on interior and exterior building lighting fixtures.

B. SHOP DRAWINGS:

1. Submit dimensioned drawings of lighting fixtures. Submit fixture shop drawings in booklet form with separate sheet for each fixture, assembled in luminaire "type" alphabetical order, with proposed fixture and accessories clearly indicated on each sheet. Submit all available standard color samples with the shop drawings. If standard colors are not acceptable, a color sample will be provided to the fixture manufacturer. Return of the shop drawings will be delayed until color samples are provided. Submit ballast manufacturer cut sheets. Submit a list of all lamps used on all projects.

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PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. Subject to compliance with requirements, provide products of one of the following (for each type of fixture):

1. HID MAGNETIC BALLASTS:

a. Advance Transformer Co.

b. Universal Lighting Technologies Co.

c. Venture Lighting International

2. INCANDESCENT AND FLUORESCENT LAMPS:

a. General Electric Co.

b. Osram Sylvania

c. Phillips Lighting Corp.

3. HID LAMPS:

a. General Electric Co.

b. Osram Sylvania

c. Phillips Lighting Corp.

d. Venture Lighting International

2.2 INTERIOR AND EXTERIOR LIGHTING FIXTURES:

A. GENERAL:

1. Provide lighting fixtures, of sizes, types and ratings indicated complete with, but not necessarily limited to, housings, lamps, lamp holders, reflectors, ballasts, starters, and wiring. Label each fixture with manufacturer's name and catalog number. Provide all enclosed fixtures with positive latch mechanisms; spring tension clips not acceptable. Provide all exterior fixtures with damp or wet location label as required by application.

B. SUPPORT REQUIREMENTS:

1. Provide all pendant and stem hung fixtures with flexible ball joint hangers at all points of support. Equip hooks used to hang fixtures with safety latches. Provide all detachable fixture parts, luminous ceiling accessories, louvers, diffusers, lenses, and reflectors with locking catches, screws, safety chain, or safety cable.

2. Comply with manufacturer's written recommendations for all lamp ballast combinations.

3. Equip outdoor fixtures with low temperature starting ballasts.

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C. BALLAST FUSING:

1. Provided in-line fusing for all fluorescent and HID ballasts. For fluorescent ballasts, provide GLR fuses and HLR -in-line fuse holders for each ballast. For HID fixtures provide KTK fuses and HPF fuse holders. Size fuses per ballast manufacturer's recommendation.

   a. Comply with manufacturer's written recommendations for all lamp ballast combinations.

   b. Equip outdoor fixtures with low temperature starting ballasts.

D. FLUORESCENT LAMP BALLASTS: - (ELECTRONIC):

1. Provide rapid start, fluorescent programmable start lamp ballasts capable of operating lamp types indicated, with power factor(ratio of actual power to apparent power) above 95%, ballast factor of .71, and operating with audible noise level lower than the quietest C.B.M. certified ballast for the same application, listed as class A. Provide ballasts which comply with applicable state, federal, and industry standards and:

   a. Are UL listed,

   b. Comply with FCC requirements governing electromagnetic and radio frequency interference.

   c. Comply with IEEE standards for line voltage transient protection, and ANSI C.62.41 for location director A3 in the normal mode and location category A1 in the common mode.

   d. Comply with ANSI and IEEE standards for harmonic distortion

2. Light output shall not vary by more than 1% over a plus or minus 10% variation in line voltage, and shall not vary more than 5% of light output of equivalent C.B.M. certified ballast. See drawings and schedules for input voltage requirements. Ballasts shall consistently start and operate lamps from a supply line voltage of plus or minus 10% from nominal line voltage.

3. Provide ballasts which operate at a frequency above 20K hz from an input frequency of 60 hz; have an efficacy factor (relative light output per watt consumed) at least 10% above the C.B.M. certified electromagnetic system for the same application; and have a lamp crest factor (ratio of peak to R.M.S. lamp current) of 1.7 or less. Ballasts shall have a total current harmonic distortion of less than 10%.

4. All T5 and Compact electronic ballasts shall be programmed rapid start for maximum lamp life on shorter start cycles. Filament voltage shall be applied prior to the application of open circuit voltage to allow adequate heating of the filaments and then open circuit voltage is applied to start the lamps. Ballasts shall provide for a minimum lamp starting temperature of 0 degrees F. T8 ballasts shall be rapid start unless specified on the fixture schedule otherwise.

5. Ballasts for lamps of T5, T4, and T2 diameter shall contain end-of-life sensing circuitry to prevent lamp, lamp base, or socket damage at end-of-life.

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6. Ballast manufacturer shall warrant ballasts for T8 and T5 lamps to be free from defects in material or workmanship for at least 5 years from date of manufacture. Ballasts for T4 and smaller shall be 3 years. Contractor shall provide warrantee in accordance with other sections of this specification. Warranty shall include an allowance for nominal replacement labor and replacement of defective product.
7. Comply with manufacturer's written recommendations for all lamp ballast combinations. Provide electronic ballasts of one of the following:
   a. Motorola
   b. Advance Transformer Company
   c. Howard Industries
   d. Osram Sylvania
   e. Universal Lighting Technologies Co.
8. CBM LABELS:
   a. Provide fluorescent-lamp ballasts which comply with Certified Ballast Manufacturers Association standards and carry the CBM label.

E. FLUORESCENT LUMINAIRES

1. Fluorescent luminaries that utilize double-ended lamps and contain ballast(s) that can be serviced in place shall have a disconnecting means internal to the luminaries to disconnect simultaneously from the source of supply all conductors of the ballast, including the grounded conductor. Disconnects shall not be required under the following exceptions:
   a. Luminaries located in hazardous locations.
   b. Luminaries used for egress lighting.
   c. Cord-and-plug luminaries.
   d. In industrial establishments with restricted public access where conditions of maintenance and supervision ensure that only qualified persons service the installation.
   e. Where more than one luminaire is installed in a space and where disconnecting the supply conductors to the luminaire will not leave the space in total darkness.

F. FLUORESCENT LAMPS:

1. Equip interior fluorescent fixtures with full light output, T8 lamps where available as standard products. Where applicable, equip fixtures with lamps as follows:

4' T8	3150	Initial Lumens, average life of 30,000 hours.

   a. Sylvania Octron

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b. General Electric

c. Phillips

2. Provide fluorescent lamps with low levels of mercury, capable of acceptance of the Environmental Protection Agency (EPA) through the TCLP (Toxic Characteristic Leaching Procedure).

G. HIGH-INTENSITY-DISCHARGE-LAMP BALLASTS:

1. Provide HID ballasts, of ratings, types and makes as recommended by lamp manufacturer, which properly match lamps to power line by providing appropriate voltage and impedances for which lamps are designed. Equip exterior fixtures with low temperature starting ballasts. Provide high power factor, or power factor improved ballasts.

H. HID LAMPS:

1. Equip fixtures with HID lamps as specified. Provide coordinated lamp ballast combination to ensure full light output (rated lumens) of lamp. Where lamp manufacturer recommends operation of lamp in enclosed fixtures, provide suitable enclosure for fixtures specified. Include detailed drawing of enclosure with shop drawing submittal.

I. DIFFUSERS:

1. Where plastic diffusers are specified, provide 100 percent virgin acrylic compound; minimum thickness, .125 inches.

PART 3 - EXECUTION

3.1 INSTALLATION OF LIGHTING FIXTURES

A. Install lighting fixtures at locations and heights as indicated, in accordance with fixture manufacturer's written instructions, applicable requirements of NEC, NECA's "Standards of Installation", NEMA standards, and with recognized industry practices to ensure that lighting fixtures fulfill requirements.

B. Coordinate with other work as appropriate to properly interface installation of lighting fixtures with other work. Consult architectural reflected ceiling plan for exact location of all lighting fixtures.

C. Provide all necessary supports, brackets, and miscellaneous equipment for mounting of fixtures. Support all ceiling mounted fixtures from the building structure; independent of the ceiling system, unless noted. Support each recessed fixture (fluorescent incandescent, and/or HID) from the building structure with #12 ga. steel wire attached to each corner (in addition to supports normally provided for attachment to the ceiling system). Provide backing supports above (or behind) sheetrock, plaster and similar ceiling and wall materials. Support surface mounted ceiling fixtures from channel. Support ceiling mounted outlet boxes independent of the raceway system, and capable of supporting 200

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pounds. Feed each recessed fixture directly from an outlet box with flex conduit as required; do not loop from fixture to fixture. See plans for additional details.

D. Provide each lay-in light fixture with at least 36" (Not to exceed 72") of 3/8" steel flexible conduit.

E. Coordinate lighting in mechanical room with duct and equipment locations.

F. Provide gypsum board protection as required, (acceptable to fire official having jurisdiction) to ensure fire rating of each ceiling in which fixtures are installed.

G. COORDINATION MEETINGS:

1. Meet at least twice with the ceiling installer. Hold first meeting before submittal of shop drawings to coordinate each light fixture mounting condition with ceiling type. During second meeting, coordinate fixture layout in each area.
2. Meet at least once with the mechanical installer prior to fabrication and installation of duct work. Coordinate depth and location of all fixtures and duct work in all areas.

H. ADJUST AND CLEAN:

1. Clean lighting fixtures of dirt and debris upon completion of installation.
2. Protect installed fixtures from damage during remainder of construction period. Repair all nicks and scratches to appearance of original finish.

I. SPARE PARTS:

1. Provide a spare set of diffusers (acrylic and/or glass only) for each fixture type and one for each additional 10 fixtures of each type; not to exceed 10 spares for any single fixture type.
2. In addition, furnish stock of replacement lamps amounting to 15 percent (but not less than one lamp) of each type and size used. Deliver replacement stock as directed to Owner's storage space.

3.2 FIELD QUALITY CONTROL:

A. Upon completion of installation of lighting fixtures, and after building circuitry has been energized, apply electrical energy to demonstrate capability and compliance with requirements.

B. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise remove and replace with new units, and proceed with retesting.

C. At the time of Substantial Completion, replace lamps in interior lighting fixtures which are observed to be noticeably dimmed after the Contractor's use and testing, as judged by Architect/Engineer.

D. GROUNDING:

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1. Provide equipment grounding connections for each lighting fixture.

END OF SECTION 26 5100

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SECTION 26 5600 - EXTERIOR AREA LIGHTING

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. Division-26 Basic Materials and Methods sections apply to work specified in this section.

1.2 DESCRIPTION OF WORK:

A. Types of lighting fixtures in this section are indicated by schedule and include the following:

1. High-Intensity Discharge (HID)
2. Fluorescent
3. Incandescent/Halogen
4. LED (Light Emitting Diode)

B. Excavation and backfilling for exterior area lighting poles, standards and foundations are specified in applicable Division-26 general provision sections.

C. Concrete for embedding poles, and for pole foundations and footings is specified in other sections of specification. Provide pole bases under this section of the specification.

D. Refer to other Division-26 sections for cable, wire and connectors required in connection with exterior area lighting poles and standards.

1.3 QUALITY ASSURANCE:

A. Comply with NEC, NEMA and ANSI/IES requirements as applicable to location and installation of lighting poles and standards. Provide lighting components and fittings which are UL-listed and labeled.

B. Comply with other portions of specification as applicable for forming, splicing, and curing of concrete bases provided under this section.

1.4 SUBMITTALS:

A. PRODUCT DATA: Submit manufacturer's data on lighting units, including certified dimension drawings of components including, but not necessarily limited to, poles and standards, mast arms, brackets, hardware and fixtures.

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PART 2 - PRODUCTS

2.1 MANUFACTURER: Subject to compliance with requirements, provide products as scheduled on drawings.

A. FUSES: Provide (3) spare fuses for each type and size used.

B. CONCRETE: 3000 psi Class.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. Install area lighting units as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC, NESC and NEMA standards and with recognized industry practices to ensure that lighting units fulfill requirements.

B. Coordinate with other work as necessary to properly interface installation of roadway and parking area lighting with other work.

C. Comply with NEC 300-5 (or State of Utah requirement, whichever is most stringent), for raceway burial depth.

D. Mount lighting units on concrete bases as indicated, complete with anchor bolts and reinforcing bars. Coordinate proper size and location of all bases as required to ensure proper installation. Provide 3000 psi class concrete; hand rub all exposed concrete to uniform, smooth finish.

E. Deliver poles to job site with factory finish paint.

F. Set poles and standards plumb. Support adequately during backfilling, or anchoring to foundations.

G. Provide sufficient space encompassing hand access and cable entrance holes for installation of underground cabling.

H. Provide Bussman HEB fuseholder (or Littelfuse LEB-XX-S) with "breakaway" receptacles in all conductors running to the top of each pole. Locate fuseholder at hand hole or in base junction box as applicable. Provide KTK fuses in each phase conductor, sized 1.5 times maximum full load current of ballasts served by each conductor. Do not exceed rating of circuit overcurrent protective device. Provide fuse blanks in neutral conductors. Make up all other splices in pole or pole base using Scotchcast 400 Resin for watertight connection.

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3.2 GROUNDING:

A. Provide equipment grounding connections for each lighting unit installation.

END OF SECTION 26 5600

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SECTION 27 1500 - TELEPHONE/DATA SYSTEMS

PART 1 – GENERAL

1.1 SCOPE OF DOCUMENT:

A. The following are project specifications to which all cabling systems must adhere. These specifications apply to all installers (hereinafter referred to as "the Contractor") for all sites, which require, standards-compliant structured cabling systems and shall be used for all the installation, testing, and acceptance of the information transport systems as described in the attached specifications. Prices quoted of the installation facilities shall be all-inclusive and represent a complete installation at such sites as prescribed in this specification and contract documents. The Contractor shall be solely responsible for all parts, labor, testing, acceptance and all other associated processes and physical apparatus necessary to turn-over a completed system fully warranted and operational for acceptance by the Customer. Final acceptance of the installation shall be in writing by the Architect and Engineer.

B. In all instances where Standards are cited, it is assumed Installer will have familiarity with and implicitly follow the recommendations of the most current version of the Standard referenced at the time of installation. Compliance with most current Standards is the sole responsibility of the Contractor.

1.2 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. Division-26 Basic Materials and Methods sections apply to work specified in this section.

1.3 SCOPE OF WORK:

A. The extent of telephone/data system work is indicated by drawings and is hereby defined to include, but not be limited to racks, cabinets, visi blocks, cables, raceway, outlet boxes, device plates, backboard, and grounding. Contractor is responsible for installation of all specified and unspecified necessary and miscellaneous items required for delivery of a complete and functional data cabling and device system.

B. Contractor shall provide complete cable and outlet system as indicated on the drawings and described herein. Work shall include all associated infrastructure transmission components and support appliances including, but not be limited to cable, jacks, terminal blocks, racks, cabinets, wire management, labeling, transient voltage surge suppression, patch cords, telecommunications grounding system and all terminations as specified herein.

C. Contractor shall provide system testing as described herein using up-to-date and industry accepted Level IIIe test equipment appropriate to the types of links being tested and in accordance with the latest edition of IEC 61935-1. All testers used shall be factory calibrated within one year of use with references set daily prior to testing.

D. All active equipment (electronics) will be owner furnished and owner installed.

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E. Contractor shall be solely responsible for all parts, labor, testing, documentation and all other associated processes and physical apparatus necessary to turn-over the completed system fully warranted and operational for acceptance by Owner and Engineer.

F. Contractor shall provide all labor, materials, tools and equipment required for the complete installation of work called for in the Construction Documents.

G. Copper solution shall be Systimax and Fiber Solutions shall be Corning.

H. Contractor shall provide conduit from telecommunications outlet/connector to EF/ER/TR/TE.

1.4 CONTRACTOR QUALIFICATIONS

A. The contractor shall be fully conversant and capable in the cabling of low voltage applications such as, but not limited to voice and data network systems. The Contractor shall at a minimum possess the following qualifications:

1. Must have at a minimum (1) RCDD certified individual employed full time at the time of bidding. PROVIDE PROOF OF RCDD CERTIFICATION IMMEDIATELY UPON JOB AWARD.
2. BICSI Certified Installers or equivalent.
3. Possess those licenses/permits required to perform telecommunications installations in the specified jurisdiction.
4. Have a minimum of 5 years in the communications structured cabling business and be able to provide three owner references for the type of installation described in this specification for projects within the last 18 months.
5. Personnel trained and certified in fiber optic cabling, splicing, termination and testing techniques. Personnel must own [not rent] a light meter or fiber test adapter head, and OTDR and shall be factory certified by the manufacturer of the products being installed.
6. Personnel trained in the installation of pathways and support for housing horizontal and backbone cabling.
7. Personnel knowledgeable in local, state, province and national codes, and regulations. All work shall comply with the latest revision of the codes or regulations. When conflict exists between local or national codes or regulations, the most stringent codes or regulations shall be followed.
8. Be factory certified by the manufacturer used in installation of all transmission components of all copper and fiber links and able to provide the manufacturer warranty.

1.5 QUALITY ASSURANCE

A. Required Pre-Telecommunications Construction Meeting with Communications Engineer: Electrical contractor/representative AND Communications Contractor will be required to attend a pre-communications construction meeting (approximately 30-60 minutes) with Communications representative in the electrical engineers office prior to communications construction commencement. This meeting will address any questions on the part of the contractor and the expectations of the Engineer with regard to

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specifications, plans and site visits for both rough and finish electrical work.

1.6 APPLICABLE CODES AND STANDARDS

A. Contractor is responsible for compliance with all applicable portions of the NEC code as to type of products used and installation of components. All materials used shall be products and materials which have been UL-listed and labeled. All installed products shall comply with applicable NEMA standards for low loss extended frequency cable.

B. In addition installation shall adhere to the following Standards:

1. ANSI/TIA-568-C.0 - Generic Telecommunications Cabling for Customer Premises, or most recent edition at the time of installation
2. ANSI/TIA-568-C.1 – Commercial Building Telecommunications Cabling Standards, or most recent edition at the time of installation
3. ANSI/TIA-568-C.2 - Balance Twisted Pair Communications and Components Standards, or most recent edition at the time of installation
4. ANSI/TIA –942 -Telecommunications Infrastructure for Data Centers, or most recent edition at the time of installation
5. TIA-569-B - Commercial Building Standard for Telecom Pathways and Spaces, or most recent edition at the time of installation
6. ANSI/TIA-606-A – Administration Standard for the Telecommunications Infrastructure of Commercial Buildings, or most recent edition at the time of installation
7. ANSI-J-STD-607-A - Commercial Building Grounding/Bonding Requirements, or most recent edition at the time of installation
8. ANSI/TIA 1152 – Testing of Copper Links
9. BICSI Telecommunications Distribution Methods Manual, 12th edition or most recent edition at the time of installation.
10. TIA 758-A - Customer owned Outside Plant Telecommunications Infrastructure Standard (2004), including all applicable addenda and the most recent revision at the time of installation.
11. BICSI Information Transport Systems Installation Manual - 5th edition or most recent edition at the time of installation.
12. ANSI/NFPA-70- 2008 National Electrical Code, revision, or most recent revision at the time of installation.
13. ANSI/IEEE C-2 - 2007 National Electrical Safety Code or most recent revision at the time of installation.
14. OSHA Standards and Regulations All applicable
15. Local Codes and Standards All applicable

C. Note: Anywhere cabling standards conflict with electrical or safety codes, Contractor shall defer to NEC and any applicable local codes or ordinances, or default to the most stringent requirements listed by either. Knowledge and execution of applicable codes is the sole responsibility of the Installer. Any code violations shall be remedied at the

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Contractor's expense.

1.7 ACCEPTABLE MANUFACTURERS:

A. General:

1. Unapproved product substitutions are not allowed. Contractor wishing to substitute any products for those expressly specified shall submit three samples of the alternate product to Engineer no less than two weeks prior to the last addendum accompanied by all engineering documents, drawings and third party test data proving mechanical and transmission equivalency. Acceptance of substitutions shall be received from Engineer in writing. All unapproved substitutions installed shall be removed by Contractor who shall assume all costs for removal and replacement with approved products. Such costs shall include, but not be limited to labor, materials, as well as any penalties or fees for late completion.

B. APPROVED MANUFACTURERS:

1. Contractor shall select only one line item in the each section of Parts 2, 3, and 4. Contractor shall NOT utilize multiple line items for the project within each Part. For example, if Panduit / General Cable is selected to be used for the project, all copper cabling and connectivity shall be by Panduit or General Cable. No other manufacturer or combination of manufacturers may be used for the copper cabling or connectivity equipment.

2. Copper Cabling / Connectivity Approved Manufacturers:

a. CommScope Systimax

3. Fiber Cabling Approved Manufacturers

a. Corning

4. Non-Cabling / Connectivity Approved Manufacturers:

a. Same manufacturer from Part 2.

b. APC

c. Great Lakes Cabinets

d. Chatsworth

e. Belden

1.8 SUBMITTALS:

A. Provide electronic submittals in Adobe PDF format within one file.

B. Provide submittals for all racks/cabinets; devices, cabling, firestopping solutions, grounding equipment, and miscellaneous equipment to be used on project. Where multiple part numbers are listed on a datasheet/cutsheet, highlight or circle applicable part.

C. Provide submittals showing complete racking layout in plan and elevation view to scale. Coordinate exact rack layout with Owner Information Technology Representative prior to submittal.

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D. For any unspecified components, Contractor shall submit manufacturer's data and installation details for all devices, plates, cables, termination blocks, patch cords, line suppression blocks, wire management, labels, and similar equipment.

E. Provide color samples of all available standard color faceplates to architect.

F. Provide proposed labeling scheme for approval by owner/engineer.

G. Provide results of all copper and fiber optic cable tests.

PART 2 - PRODUCTS

2.1 GENERAL:

A. All products shall be in new condition and UL listed.

B. Provide complete raceway, outlet boxes and miscellaneous items. All conduit utilized shall be EMT grade.

C. Provide 4-11/16" x 2-1/8" deep square outlet box at each outlet location with single gang plaster or tile ring. Provide wall board adapters as necessary.

D. Communication grounding and bonding shall be constructed and installed to meet or exceed the requirements of the National Electrical Code (NEC), IEC 1000-5-2 and ANSI/J-STD--607-A throughout the entire grounding system.

E. All termination hardware shall be rated to meet Category 6 specifications.

2.2 ENTRANCE FACILITY (EF) / EQUIPMENT ROOM (ER) / TELECOMMUNICATIONS ROOM (TR)

A. General:

1. Contractor shall be responsible for the adequate and appropriate design of all racking systems, paying particular attention to sizing of all cable management troughs and supports both horizontal and vertical installation of patch panels and wire management into rack.

2. Provide line surge suppressors at main telephone board in ER for all incoming phone lines if not provided by service provider. Provide ground connection to TMGB.

B. Provide and install the following, see specifications for each item in this document:

1. Wall Linings in each EF, ER, and TR:

a. In addition to the architectural walls, provide plywood wall lining that mounts at 8" A.F.F which shall:

i. Be fire-rated or treated on all sides with at least two coats of fire-resistant light-colored paint. Fire-retardant plywood is also acceptable. Leave fire rated stamp on plywood unpainted.

ii. Have walls lined with A/C grade or better, void-free plywood, 8 feet high with a minimum thickness of ¾". See plans for additional wall locations.

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iii. Install the plywood with grade A surface exposed. Plywood shall be securely fastened to wall-framing members to ensure that it can support attached equipment.

iv. Use flush hardware and supports to mount plywood.

v. Plywood shall be void free and kiln-dried to a maximum moisture content of 15 percent to avoid warping.

2. Main Cross Connect (MC) / Horizontal Cross Connects (HC):

a. Floor Mounted Racks (See Plans For Locations):

i. Provide two post 19” wide minimum 7’ tall EIA aluminum rack with ANSI/EIA 310-D rail size, 45RU capacity, painted black, top flanges, and mounting holes.

ii. Provide paint-piercing washers to electrically bond racks.

iii. Approved Equipment

1. Chatsworth 55053-703 Standard Rack
2. CommScope RK3-45A
3. Cooper B-Line SB556084XUFB
4. Panduit R2P
5. TE 1933559-1

b. Fiber Patch Panels, Rack Mounted Fiber Trays, and Fiber Adapter Panels

i. Provide flat fiber adapter patch panels which hold adapter panels as required to complete project with a maximum of 36 strands in 1RU.

ii. Provide wall mounted connector housing sliding type fiber trays as required to complete project.

iii. Provide OM4 fiber adapter patch panels which contain modular, dual LC adapter panels as required to complete project. Color for OM4 ports to be aqua, color for OS2 ports to be yellow single mode and orange for muli mode.

iv. Provide minimum 25% spare capacity of fiber adapter panels. Provide additional mounted fiber adapter patch panels if necessary to meet 25% spare capacity requirement.

v. Approved Equipment – Corning

d. Vertical Cable Managers:

i. Provide a vertical cable management panel on both sides of rack.

ii. Manager shall consist of a metal backbone with cable management fingers that align with EIA rack spacing. Provide cover for all cable management.

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iii. Vertical panel shall be able to manage all the cable on the rack without the aid of horizontal cable managers.

iv. Size all vertical cable managers according to factory recommendations for the cable being installed. In no case shall design require more than 35% fill ratio when rack is fully populated.

v. Provide molded plastic slack spools in front to facilitate minimum bend radius compliance.

vi. Minimum width to be 6”.

vii. Approved Equipment

1. Chatsworth Velocity Double Sided 1391X-703
2. CommScope VCM-DS-84-xB (6”, 8”, 10”, 12”).
3. Cooper B-Line RCM Vertical Managers
4. Panduit PatchRunner PRV6
5. Leviton 8980l-VFR (8”)
6. TE 1933534-1 (avail. 6", 10", 12")

e. Horizontal Cable Management

i. Provide horizontal cable management capable of managing copper and fiber cables.

ii. Manager shall consist of bend radius control throughout the fingers, pass through holes, and transitions between horizontal and vertical pathways.

iii. Provide front hinged cover that shall open 180 degrees.

iv. Manager should mount to standard EIA 19” rack.

v. Size according to factory recommendations for the cable being installed. In no case shall design require more than 40% fill ratio when rack is fully populated.

vi. Approved Equipment

1. Panduit NMFX, where X refers to the number of rack units
2. CommScope HTK-19-SS-XU, where X refers to the size.
3. Cooper B-Line RCM+ SB87019S2FB
4. TE 1933532-1 (avail. 1,2,3RU)

f. Power Outlet Units

i. Provide rack mount power outlet unit with amperage and voltage indicated on plans. Unit shall have ten NEMA 5-20R receptacles per circuit and internal thermal breaker of power outlet unit’s listed amperage.

ii. Approved Equipment

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1. Server Technology CB-12H1-C20.
2. Geist BRN100-1025.
3. Panduit Rack Mount POU CMRPSH20
4. Leviton 4520-10S
5. Minute Man MMPD1420HV
6. Raritan and other manufacturers already approved within this document are also approved.

g. Uninterruptible Power Supply (UPS)

i. Provide 1500VA, 120V rack-mounted UPS for each rack/cabinet on project with capability of providing backup to the full connected load for a minimum of 10 minutes, regardless of shown load on electrical panel schedules.

ii. Provide a minimum of (2) output receptacles.

iii. Provide submittal for each UPS showing run time graph that shows compliance with the specifications.

iv. Approved Manufacturers

1. APC
2. Other approved manufacturer.

h. Cable Tray (only within the EF/ER/TR)

i. Provide overhead basket tray:

1. Size tray according to quantity of cables entering space. However, in no case shall the tray be smaller than 4” high by 6” wide. Do not exceed 50% cable fill of tray.

2. For overhead installations, utilize profile supports to support tray every 5’-0”.

3. For wall mounted installations, utilize shelf brackets to support tray every 5’-0”.

4. Provide blind ends to provide closure for a dead-end tray.

5. Provide cable rollers, two at each 90 degree bend. A radius shield or horizontal bend radius may also be used in lieu of cable rollers.

6. Provide drop-out fittings, or waterfalls, over each cabinet of sufficient quantity to provide an acceptable path for cables to enter equipment. For single cables leaving the tray, utilize a cable drop-out in lieu of a waterfall.

7. Provide conduit to tray adapters for each conduit terminating to cable tray. Brace top of rack to the wall or ceiling utilizing threaded drop rod. Similar to Chatsworth Universal Earthquake Bracing Kit 10562-

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001.

ii. Acceptable Manufacturers

1. Chatsworth Universal Cable Runway
2. Cooper B-Line Redi Rail Runway
3. Cablofil PW Ladder Tray
4. CommScope Cable Runway
5. Panduit WyrGrid Cable Tray

2.3 CABLING DISTRIBUTION SYSTEMS AND MISCELLANEOUS EQUIPMENT

A. General:

1. Provide plenum rated cable if required, cabling must be appropriate for the environment in which it is installed. Provide wet rated cable for all wet locations, including any conduit in or below slab on grade.

2. Contractor shall be responsible for sizing all pathways such that newly installed cable represents not more than a 35% fill as per manufacturer's directions. Overfilled pathways are the sole responsibility of the Contractor who shall remove and reinstall at Contractors expense.

3. Provide cabling rated for the environment in which it is installed (i.e riser, plenum, outdoor). All cabling installed in wet locations (i.e. underground conduit, conduit in slab on grade) shall be listed for use in wet locations.

B. Backbone Cabling Distribution System – Optical Fiber

1. General:

a. Provide an optical fiber backbone cabling distribution system between telecommunication spaces. Provide OFNR or OFNP as required. Provide 900µm tight-buffered optical fiber cable for premise cable and loose tube for outside plant cable..

b. Provide fiber jumpers of appropriate length and cable type for each terminated optical fiber port to be connected.

2. Single-Mode Fiber Optic Cable (OS2)

a. All singlemode optical fiber cabling shall be 9/125µm.

b. Provide minimum of two strands for every 48-port patch panel for pathways exceeding 1.2 miles.

c. Approved Equipment - Corning

3. Multi-Mode Fiber Optic Cable (OM4)

a. All multimode optical fiber cabling shall be 62.5µm/125µm micron laser-optimized cable, designation OM4.

b. Provide hybrid cable of 12-strands of OM4 and 12-strands of OS1/OS2 between each EF/ER, ER/TR, and TR/TE. See riser diagram for

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additional information. Use the same cable between telecom rooms as the cable that enters the building.

c. Color shall be orange.

d. Approved Equipment: Corning

4. Connectors:

a. Provide LC-Duplex Connectors.

b. LC-Duplex Connectors shall have a cleave/polish termination process which incorporates use of a reliable anaerobic adhesive which has a high resistance to environmental extremes.

c. Polish type connectors are preferred.

d. For all simplex connectors, provide duplex type clip.

e. Approved Manufacturers: Corning

C. Backbone Cabling Distribution System – Copper

1. General:

a. Provide copper backbone distribution system between telecommunication spaces as shown on drawings.

2. Backbone Cabling Distribution System

a. Provide multiple pair Cat 3 cable, for analog phones, with wire count as shown on drawings. 25 pair unless otherwise noted.

b. Provide copper patch cables of appropriate length and cable type for each terminated patch panel port with an additional 25% spare.

c. Phone back bone cables terminate on 66 blocks.

d. Acceptable Manufacturers:

i. Copper backbone cabling shall be by same manufacturer as copper horizontal cabling.

3. Copper Termination Blocks:

a. Provide termination 66 blocks that support Category 3 applications and facilitate cross-connection using cross- connect wire.

b. Provide termination blocks for voice and data as required for all building telecommunications needs.

c. Analog voice – 66 style blocks

d. Data/IP Phones – Systimax Visi 360

e. Provide wiring spindles and channels as necessary to allow neat bundling of all wire and cable. Provide wiring channel (horizontal) above and/or below each termination block. Provide wiring channels by same manufacturer of termination block. Provide Velcro type ties for all cables

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at telephone backboard not run in conduit or channels. Provide wiring channel from demarcation point to termination block.

f. Approved Equipment: CommScope Systimax

4. Primary Protection (Surge Protection)

a. General

i. Provide and install surge protection for each pair of copper cabling between buildings.

ii. Surge suppressions shall be achieved through 5-pin, solid state, plug-in type modules for each conductor pair.

iii. Provide necessary grounding of equipment to building electrical ground. Size all grounding conductor based on distance to electrical ground according to the requirements of this section.

iv. Provide 25% spare modules.

v. Approved Equipment

1. For copper multi-pair backbones

a. ITWLinx ML25-CAT5-75

D. Horizontal Cabling Distribution System – Balanced Twisted Pair

1. General:

a. Provide and install appropriate number of Category 6 horizontal cables, patch cables, work area cables, for all terminated data drops, between switches, etc. so that building-wide networking will be operational once all installation is complete.

2. Horizontal Cabling

a. Provide Cat 6 UTP, mid-compliant, 4-Pair 100Ω Balanced Twisted Pair Cable to all locations shown on plans.

b. Provide cabling rated for the environment in which it is installed (i.e underground conduit, conduit in slab on grade). All cabling installed in wet locations shall be listed for use in wet locations.

c. Provide a minimum of (2) cables, unless otherwise noted, to each location shown on plans.

d. Horizontal cable shall be blue if plenum rated. Non plenum rated cable shall be slate (gray).

e. Approved Equipment

Manufacturer	Model	Riser	Plenum
CommScope	GigaSPEED XL	1071E	2071E

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3. Patch and Work Area Cables:

   a. Provide and install (1) 7 foot long Cat 6 patch cable for each workstation and (1) Visi 360 patch cable of appropriate length required for the installation TR/TC. Provide half of the TR/TC patch cables in 5 foot lengths and the remaining half in 7 foot lengths.

   b. No patch or work area cords shall in any case exceed in total 10 meters as per TIA Standard unless design includes Standards compliant MUTOA (multi-user termination outlet) and work area cord adjustments are made according to recommendations for zone cabling contained within TIA 568-C or most recent revision at the time of installation. Coordinate with owner for preferred patch cord lengths at patch panel and work area.

   c. Copper patch cord and work area outlet cabling must be provided by the same manufacturer and meet the same performance standards as the horizontal cabling.

   d. Patch cord and work area cables shall be gray.

   e. Provide (2) lengths to be determined on site of 2-strand optical fiber patch cable from wall connector housing to the rack in each comm. Room. SM or MM shall be determined by Owner. The cable shall be provided by the same manufacturer and meets the same performance standards as the backbone optical fiber.

4. Telecommunications Outlets/Connectors (See Plans For Locations):

   a. Sloped Faceplates:

      i. Provide modular type information outlets with sloped telephone jack or data outlet. Provide single gang faceplate kits to allow up to six data or voice jacks as shown on plans. Provide faceplate kits for wall outlets in colors and materials that match power wiring device plates. Provide faceplate kits that allow labeling schemes described herein. Faceplates shall accept STP, UTP, fiber optic or audio/video modules as an option.

      ii. Blank off all unused ports.

      iii. Color: Standard color as selected by owner/architect.

   b. 8P8C Angled Connector:

      i. Provide Category 6/Class E eight-position eight-contact (8P8C) jack, The termination cap shall be color coded for T568A and T568B wiring schemes.

      ii. Be a Category 6/Class E eight-position jack module that terminates on unshielded twisted 4 pair, 22 – 26 AWG, 100 ohm cable utilizing a 110 punch down solution. Maintain cable pair geometry and minimize untwist while minimizing stress on critical circuit-board components.

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iii. Color: Standard color as selected by owner/architect, Owner prefers black.

c. Approved equipment

Manufacturer	Model	Faceplates	Connector
CommScope	GigaSPEED XL	M14AS-xxx	MGS400-xxx

PART 3 – EXECUTION

3.1 GENERAL

A. Prior to pathway rough-in, low voltage contractor shall meet with electrical contractor to review pathway installation requirements.

B. Pathway Requirements:

1. General:

a. All pathways shall be designed, constructed, grounded and installed in accordance with all recommendations delineated within TIA 569-B and Standard TIA 942.

b. Prior to placing any cable pathways or cable, the contractor shall survey the site to determine job conditions will not impose any obstructions that would interfere with the safe and satisfactory placement of the cables. Arrangements to remove any major obstructions not identified on plans need to be determined at that time with the Engineer.

c. Paint all electrical boxes and their covers for the telephone and data system green.

2. Cable Tray Within EF/ER/TR:

a. Wrapped around room (wall support is acceptable)

b. Along equipment rows leading to cross-connects.

c. Ground tray to TGB or TMGB (whichever is closer) utilizing #6CU bare wire.

d. Coordinate tray locations with lighting, air-handling systems, and fire extinguishing systems so that fully loaded trays will not obstruct or impede their operation.

3. Racks / Cabinets:

a. Racks shall be securely attached to the concrete floor using minimum 3/8” hardware or as required by local codes and confirmed by Owner IT personel.

b. Racks shall be placed with a 36-inch (minimum) clearance from the walls on all sides of the rack. When mounted in a row, maintain a

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minimum of 36 inches from the wall behind and in front of the row of racks and from the wall at each end of the row.

4. Conduits:

a. For any interior/exterior conduit 2” and larger, utilize Maxcell Fabric Innerduct.

Conduit Size	MaxCell Size
2”	(1) Pack of MaxCell 2” 3-cell
3”	(2) Packs of Maxcell 3” 3-cell
4” or greater	(3) Packs of MaxCell 3” 3-cell

i. Include all necessary accessory parts and equipment for installation.

ii. Provide riser or plenum rated product to match environmental requirements.

iii. Contact MaxCell at 1-888-387-3828 for training on use of product.

b. Provide a quantity of one 1” conduit from each telecommunications box to nearest EF/ER/TR/TE. Flexible conduit is not acceptable as cable tends to creep, shift, or have sheath damage.

c. Provide a quantity of (2) 4” conduits as a minimum between TRs, regardless of whether noted on the drawings.

d. Provide (2) 4” conduits as a minimum between the TR’s regardless of whether noted on the drawings. Note this only applies if they are separate rooms.

e. Provide (2) 4” conduits as a minimum between the EF and ER, regardless of whether noted on the drawings. Note this only applies if they are separate rooms.

f. Achieve the best direct route parallel with building lines with no single bend greater than 90 degrees or an aggregate of bends in excess of 180 degrees between pull points or pull boxes.

g. Conduit runs shall not have continuous sections longer than 100 feet without a pull box and may only be filled to 35% capacity.

h. Ream all conduit ends and fit with an insulated throat nylon bushing with non-indenter type malleable steel fittings to eliminate sharp edges.

i. Telecommunications conduits should not be routed over or adjacent to heat sources such as boilers, hot water lines, or steam lines. Neither should they be routed near large motors, generators, photocopy equipment, or electrical power cabling and transformers.

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j. Conduits that enter an EF/ER/TR must terminate near the corners to allow for proper cable racking. Terminate these conduits as close as possible to the wall where the backboard is mounted to minimize the cable route.

k. Terminate conduits that protrude through the structural floor 3” to 5” above the surface within an EF/ER/TR.

l. After installation, conduits shall be clean, dry, unobstructed, capped for protection, labeled for identification, reamed and fitted with bushings.

m. A 200lb pull cord (nylon, 1/8” minimum) shall be installed in any empty conduit.

n. When the number of conduits requires more than one row, restrict the number of rows to two wherever practicable.

5. Pull Box Requirements:

a. NEC sized pull boxes are not acceptable. Follow BICSI and EIA/TIA 569-B guidelines for pull box sizing.

b. Provide pull boxes in sections of conduit that are 100 feet or longer, contain more than two 90 degree bends, or contain a reverse bend.

c. Conduits that enter the pull box from opposite ends should be aligned.

d. Pull boxes shall have a length 12 times the diameter of the largest conduit.

e. All pull boxes must be accessible.

C. Cabling System:

1. Follow T568B scheme for copper cabling terminations.

2. Backbone cables shall be installed separately from horizontal distribution cables. All backbone cables will be run in orange innerduct. Provide plenum rated innerduct if required, innerduct must be appropriate for the environment in which it is installed.

3. Fiber slack shall be neatly coiled within the fiber enclosure or cable tray. No slack loops shall be allowed external to the fiber panel. Each cable shall be individually attached to the respective fiber enclosure by mechanical means. Neatly tie up out of the way in Comm. Room.

4. Provide a minimum 6” service loop in each communications system junction box for balanced twisted pair. Cables shall be coiled in the in-wall boxes if adequate space is present to house the cable coil without exceeding manufacturers bend radius.

5. Provide a minimum 10’ service loop in each EF/ER/TR/TE.

6. Provide a minimum 2’ service loop at each stub-up or at each transition from conduit to cable tray.

7. Provide a minimum 6’-10’ service loop in the ceiling before the conduit travels down the wall and terminates into the communications junction box.

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8. Provide modular jacks for each installed cable at outlets shown on drawings. Blank off all unused ports on faceplate.
9. Provide Velcro type ties for all cables and install in a neat and workmanlike manner. Where applicable, use plenum rated Velcro. Where cable is installed in cable tray, bundle a maximum of 25 cables in each Velcro tie.
10. The bending radius and pulling strength requirements of all backbone and horizontal cables shall be observed during handling and after installation. Use pulling compound as recommended by manufacturer.
11. All horizontal cables, regardless of media type, shall not exceed 90 m (295 ft) from the telecommunications outlets in the work area to the horizontal cross connect.
12. The combined length of all patch cords in the EF/ER/TR and the work area shall not exceed 10m (33 ft)
13. No splices are allowed.
14. In a false ceiling environment, a minimum of 3 inches shall be observed between cable supports and false ceiling. At no point shall cable(s) rest on acoustic ceiling grids or panels.
15. Cable shall be installed above fire-sprinkler systems and shall not be attached to the system or any ancillary equipment or hardware. The cable system and support hardware shall be installed so that it does not obscure any valves, fire alarm conduit, boxes, or other control devices.
16. Cables shall not be attached to ceiling grid seismic support wires or lighting fixture seismic support wires. Where support for horizontal cable is required, the contractor shall install appropriate carriers to support the cabling.
17. Any cable damaged or exceeding recommended installation parameters during installation shall be replaced by the contractor prior to final acceptance at no cost to the Owner.
18. Pulling tension for balanced twisted pair shall not exceed 25lbf and for optical fiber shall not exceed 50lbf.
19. Pair untwist at the termination shall not exceed 0.125”. The cable jacket shall be maintained as close as possible to the termination point.
20. Cables shall be neatly bundled and dressed to their respective panels or blocks. Each panel or block shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.
21. Cable shall not be draped on, tied or otherwise secured to electrical conduit, plumbing, ventilation ductwork or any other equipment. Cable shall be secured to building supports or hangers or to additional blocks or anchors specifically installed for this purpose.
22. Copper Backbone Terminations shall terminate on 66 blocks. All horizontal cable shall be considered to be data and terminated as such.

D. Grounding System:

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1. All grounding and bonding shall be done according to ANSI J-STD-607-A, TIA 942, and NEC.
2. All cabinets/racks shall utilize paint piercing grounding washers, to be used where rack sections bolt together, on both sides, under the head of the bolt and between the nut and rack.
3. All racks shall further utilize a full-length rack ground strip attached to the rear of the side rail with the thread-forming screws provided to ensure metal-to-metal contact. Similar to Panduit RGS.
4. All active equipment from owner shall be bonded to ground. If the equipment manufacturer provides a location for mounting a grounding connection, that connection shall be utilized. All active equipment shall be bonded using the appropriate jumper for the equipment being installed using the thread-forming screws. Similar to Panduit RG.
5. Racks shall have individual, appropriately sized conductors bonded to the grounding backbone. Do not bond racks or cabinets serially – daisy-chained rack grounds will not be accepted.
6. Patch panels shall be bonded to racks using the appropriate bonding screws. Mounting rails may utilize cage nuts, threaded holes or thru hole mounting fasteners to secure patch panels to the rails.
7. Bond cable tray, raceway system, structural steel and all other metal equipment located within EF/ER/TR to the grounding bus bar utilizing copper conductors per the following schedule:
   a. ≤25’ - #4
   b. ≤50’ - #1
   c. ≤75’ - #2/0
   d. ≥75’ - #3/0
8. Provide 4” X 12” X ¼” CU Telecommunication Main Grounding Bus Bar (TMGB) with bonding conductor per schedule above to Intersystem Bonding Terminal (IBT) in each telecommunication room (EF/ER/TR) with a main cross-connect (MC).
9. Provide 2” X 12” X ¼” CU Telecommunication Grounding Bus Bar (TGB) with bonding conductor per schedule above to TMGB in each room with a horizontal cross-connect (HC).
10. Refer to electrical diagrams for additional ground connection requirements.

E. Electromagnetic Compatibility:

1. General:
   a. Do not install power feeders above or within the telecommunications room. Do not install telecommunications conduits above electrical panelboards, switchboards, transformers, motor control centers, etc.

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b. Where telecommunication cable is installed in grounded, metallic conduit near power cables, the power cables shall be kept physically separated from telecommunications cables:

i. Circuits Under 5kVA: 2” minimum separation.

ii. Circuits Over 5kVA: 6” minimum separation.

iii. Electrical motors/transformers: 48” minimum separation.

iv. Lighting ballasts: 6” minimum separation.

c. Where telecommunication cable is installed in cable tray or underground in non-metallic conduit near power cables, the power cables shall be kept physically separated from telecommunications cables by a minimum of 12”

F. EF/ER/TR Power Requirements:

1. General: Regardless of what is shown on drawings, the minimum requirements for providing power in the EF/ER/TR are as follows and shall be included in bid:

a. Two dedicated, nonswitched 120V/20A duplex receptacles, each on individual branch circuits, emergency power.

b. 120V/20A Duplex receptacles located +6” A.F.F. placed at 6 foot intervals around perimeter walls. Up to 10 receptacles may be placed on a single circuit, emergency power.

G. Firestopping:

1. Provide firestop solution equivalent to the wall/ceiling/floor rating.

2. Provide firestop labels next to each penetration with written date. Label both sides of the penetration.

3. Take picture of both sides of the firestopping seal and include in O&M documentation of all firestopped locations. Provide drawing correlating photographs to actual locations in building.

4. All penetrations through fire rated building structures (walls and floors) shall be sealed with an appropriate Firestop system. This requirement applies to through penetrations (complete penetration) and membrane penetrations (through one side of a hollow fire rated structure). Any penetrating item i.e., riser slots and sleeves, cables, conduit, cable tray, and raceways, etc. shall be properly firestopped.

5. Firestop systems shall be UL Classified to ASTM E8124 (UL 1479). A drawing showing the proposed firestop system shall be provided to the Engineer prior to installing the Firestop system(s).

6. Firestopping within conduits and sleeves shall be re-enterable. Firestopping outside and around annular space of sleeves and conduits at wall penetrations shall dry to a hard consistency. Mineral wool or other cavity stuffing shall be utilized as noted in the firestop system approved for this project.

7. Utilize firestop pass-through type devices for medium to large penetrations into fire walls/floors. Similar to STI Series SSB.

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H. Miscellaneous Equipment:

1. Arrange all terminal blocks in a manner that allows natural wiring progression and minimizes crossing of wires.
2. Provide patch cords and cross connect cables as necessary for a complete operational telephone and data network system. Consult with owner to determine any special needs such as dedicated phone lines.

PART 4 – LABELING

4.1 GENERAL

A. The contractor shall develop and submit for approval a labeling system to match the current SUU labeling Standards. Coordinate with SUU IT personel for the cable installation. The Owner will negotiate an appropriate labeling scheme with the successful contractor. At a minimum, the labeling system shall clearly identify all components of the system: racks, cables, panels and outlets. The labeling system shall designate the cables origin and destination and a unique identifier for the cable within the system. Racks and patch panels shall be labeled to identify the location within the cable system infrastructure. All labeling information shall be recorded on the as-built drawings and all test documents shall reflect the appropriate labeling scheme.

B. All telecommunications spaces, pathways, cables, connecting hardware, equipment, racks, patch panels, outlet/connectors, and grounding system shall be labeled in accordance with TIA/EIA 606-A.

C. All labels shall meet UL 969 requirements for legibility, defacement and adhesion requirements. Handwritten labels are not allowed.

D. Provide laminated plans (minimum size 11x17) of all telecommunications as-built plans (including riser diagrams) in each and every EF, ER, and TR.

4.2 TELECOMMUNICATION PATHWAYS

A. Identify each dedicated pathway (including inner ducts) for the voice and data system.

B. Label pathways at regular intervals and wherever they are accessible.

4.3 TELECOMMUNICATION CABLES

A. Identify cables at each end with a permanent label or physical/electronic tag.

1. The same alphanumeric identifiers should be used at both ends of the cable.
2. Identify cables at regular intervals throughout and wherever they are accessible.
3. Cables shall be identified by a self-adhesive label in accordance with the System Documentation Section of this specification and ANSI/TIA/EIA-606-A. The cable label shall be applied to the cable behind the faceplate that can be accessed by removing the cover plate and to the cable behind the patch panel on a section of cable that can be viewed without removing the bundle support ties. Cables labeled within the bundle where the label is obscured from view shall not be acceptable.

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4.4 CONNECTING HARDWARE

A. Identify connecting hardware items (termination blocks, cross-connects, racks, cabinets, telecommunications outlet/connectors, ports) per SUU Standards.

4.5 TELECOMMUNICATIONS GROUNDING SYSTEM

A. Identify each telecommunications grounding bus bar (TGB) and telecommunications main grounding bus bar (TMGB).

B. Identify each grounding conductor relating to the telecommunications system, including those connecting building steel, grounding electrodes, water pipes, and telecommunications structural components.

PART 5 - MISCELLANEOUS

5.1 TESTING:

A. General

1. Provide testing for all copper and fiber optic cable according to TIA/EIA standards and any other requirements of the manufacturer who will provide warranty.
2. Submit copy of current calibration of all testing equipment. Submit all test reports electronically to architect/engineer and include in O&M manuals to include test reports.
3. Correct any malfunctions. Contractor shall re-terminate/replace any cable, connection, or equipment found to be defective or non-compliant with these specifications and referenced standards.

B. Copper Cable

1. Utilize Level IIIe Tester to test all equipment and each outlet, horizontal cable, termination block, patch cords, etc. to verify compliance with requirements. Testing shall consist of industry accepted verification tests for the Category of cable installed and shall meet latest requirements of EIA/TIA cabling Standards.
2. UTP Cable and Links: All UTP cabling channel must be tested at swept frequencies up to 250MHz for internal channel performance parameters as defined in IEEE 802.3an and ANSI/TIA/EIA-568C. Certifications shall include the following parameters for each pair of each cable installed:
   a. Wire map (pin to pin connectivity)
   b. Length
   c. Insertion Loss
   d. Near End Crosstalk (NEXT)
   e. Far End Crosstalk (FEXT)
   f. Attenuation to Crosstalk Ratio Far End (ACRF)
   g. Attenuation/Crosstalk Ration (ACR)

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h. Return Loss

i. Propagation Delay

j. Delay Skew

3. All channels that fail testing parameters will be replaced at the Contractor's expense until all channels pass the performance parameters.

C. Fiber Optic Cable

1. Provide test results using an OTDR of all installed fiber optic links to demonstrate compliance with requirements. Testing shall consist of industry accepted verification tests for the type of cable installed and shall meet the latest requirements of EIA/TIA 455-53A standards. Test setup and performance shall be conducted in accordance with ANSI/TIA/EIA 526-14 Standard Method B.

2. Provide bi-directional testing of cable for both cable rated wavelengths. Results shall show compliance of cable and shall include the following parameters:

a. Attenuation

b. Length

c. Verification of Polarity

D. Owner reserves the right to hire an independent testing company to spot check the test results. If the results vary more than 10% from the results provided by the Contractor, the Contractor will be required to prove his results are correct or retest the entire system.

5.2 WARRANTY:

A. Register installation with cable/connectivity manufacturer.

B. Provide and submit all test results to owner, engineer, and manufacturer and meet all other manufacturer requirements in order to provide minimum 20 year extended product link warranty for complete cabling/connectivity installation, <u>including all copper and optical fiber utilized on the entire channel</u>. The channel warranty shall be provided by the connectivity manufacturer. Include replacement material and installation for any defective product.

5.3 OPERATING AND MAINTENANCE MANUALS:

A. Operating and maintenance manuals shall be submitted prior to testing of the system. A total of (4) hard copy O&M manuals and an Adobe PDF of the entire O&M manual shall be delivered to the Owner. Manuals shall include all service, installation, programming, and warranty, including test results for each cable.

5.4 TRAINING:

A. Provide four hours training on the operation and installation of the structured cabling system at job site, at no cost to owner.

5.5 RECORD DRAWINGS:

A. The Owner shall provide electronic (DWG) format of telephone/data system drawings on

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which as-built construction information can be added. These documents will be modified accordingly by the telecommunications contractor to denote as-built information as defined above and returned to the Owner.

B. Provide a complete set of "as built" drawings in paper and electronic (DWG and PDF) formats showing cabinets, racks, patch panels, wiring, specific interconnections between all equipment and internal wiring of equipment. Drawings are to include all labeling information used in denoting equipment used in the installation. Labeling, icons, and drawing conventions used shall be consistent throughout all documentation provided.

END OF SECTION 27 1500

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SECTION 310516 - AGGREGATE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Coarse aggregate materials.
   2. Fine aggregate materials.

B. Related Sections:
   1. Geotechnical Study.
   2. Section 310513 - Soils: Fill and grading materials.
   3. Section 312213 - Rough Grading.
   4. Section 312323.13 - Backfill.
   5. Section 312316.13 - Trenching.
   6. Section 331116 - Site Water Distribution.
   7. Section 333100 - Sanitary Sewer System.
   8. Section 333600 - Septic Tank Systems.
   9. Section 335100 - Natural Gas Distribution.
   10. Section 334000 - Storm Drainage.
   11. Section 321123 - Aggregate Base Courses.
   12. Section: Subbase preparation.

1.2 REFERENCES

A. American Association of State Highway and Transportation Officials:
   1. AASHTO M147 - Standard Specification for Materials for Aggregate and Soil-Aggregate Subbase, Base and Surface Courses.

B. ASTM International:
   1. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
   2. ASTM D1557 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (6,000 ft-lbf/ft3 (2,700 kN-m/m3)).
   3. ASTM D2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).
   4. ASTM D4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

1.3 SUBMITTALS

A. Section 013000 - Submittals: Requirements for submittals.
B. Materials Source: Submit name of imported materials suppliers.
C. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.4 QUALITY ASSURANCE

A. Furnish each aggregate material 5 from single source throughout the Work.

PART 2 - PRODUCTS

2.1 COARSE AGGREGATE MATERIALS

A. Coarse Aggregate Type A1: Natural stone or crushed rock; free of clay, shale, organic matter; graded in accordance with ANSI/ASTM C136, ASTM D2487 Group Symbol GM, GC; to the following limits:
   1. Minimum Size: 1/2 inch (25 mm)
   2. Maximum Size: 1 1/2 inch (50 mm)

   Use for free draining gravel material, pipe foundation material as indicated on the Drawings.

B. Coarse Aggregate Type A2: 1 ½ inch minus angular, crushed, free of shale, clay, friable material and debris; graded in accordance with ANSI/ASTM C136, Group Symbol GW; within the following limits: (Alternative gradations will be considered)

Sieve Size	Percent Passing
1 ½ inch	100
1 inch	80 to 95
3/4 inch	75 to 85
1/2 inch	60 to 80
3/8 inch	55 to 75
No. 4	35 to 60
No. 10	25 to 45
No. 50	8 to 25
No. 200	2 to 8

   Use for untreated base course material, structural foundation material and as shown on the Drawings.

C. Coarse Aggregate Type A3: ¾ inch minus angular, crushed, free of shale, clay, friable material and debris; graded in accordance with ANSI/ASTM C136; within the following limits: (Alternative gradations will be considered)

Sieve Size	Percent Passing
3/4 inch	100
1/2 inch	75 to 95
3/8 inch	65 to 85
No. 4	40 to 65
No. 10	25 to 50
No. 50	10 to 25
No. 200	2 to 8

   Use for pipe bedding material, pipe zone backfill and as shown on the Drawings.

D. Coarse Aggregate Type A4: Durable material free of shale, clay, organic matter, friable material and debris meeting the following limits: (Alternative gradations will be considered)

Sieve Size	Percent Passing
6 inches	100
4 inches	98 to 100
3 inches	95 to 100
2 inches	75 to 100
1 inch	40 to 80
No. 4	25 to 60
No. 200	5 to 12

   Use for the granular base course, import trench backfill, structure backfill, site fill material, and where specified elsewhere and shown on the Drawings.

E. Aggregate Type A5: Native material, free of organic material, friable materials and debris.
   Maximum allowable size is three (3) inches.
   Use for trench backfill and structure backfill.

2.2 FINE AGGREGATE MATERIALS

A. Fine Aggregate Type A6 (Sand): Natural river or bank sand; free of silt, clay, loam, friable or soluble materials, and organic matter; graded in accordance with ASTM C136 ASTM D2487 Group Symbol SW SP; within the following limits:

Sieve Size	Percent Passing
No.4	100
No.14	10 to 100
No.50	5 to 90
No.100	4 to 30
No.200	0

2.3 SOURCE QUALITY CONTROL

A. Section 014000 - Quality Control Services: Testing and inspection services.
B. Coarse Aggregate Material - Testing and Analysis: Perform in accordance with ASTM D1557, ASTM D4318, ASTM C136.
C. Fine Aggregate Material - Testing and Analysis: Perform in accordance with ASTM D1557. ASTM D4318. ASTM C136.
D. When tests indicate materials do not meet specified requirements, change material and retest.

PART 3 – EXECUTION

3.1 EXCAVATION

A. Stockpile excavated material meeting requirements for coarse aggregate materials and Fine aggregate materials.
B. Remove excess excavated materials not intended for reuse, from site.
C. Remove excavated materials not meeting requirements for coarse aggregate materials and fine aggregate materials from site.

3.2 STOCKPILING

A. Stockpile materials on site at locations designated by Architect/Engineer.
B. Stockpile in sufficient quantities to meet Project schedule and requirements.
C. Separate different aggregate materials with dividers or stockpile individually to prevent mixing.
D. Direct surface water away from stockpile site to prevent erosion or deterioration of materials.
E. Stockpile unsuitable and hazardous materials on impervious material and cover to prevent erosion and leaching, until disposed of.

3.3 STOCKPILE CLEANUP

A. Remove stockpile, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.

END OF SECTION

SECTION 311000 - SITE CLEARING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Removing surface debris.
2. Removing designated paving, curbs, and slabs.
3. Removing designated trees, shrubs, and other plant life.
4. Removing abandoned utilities.

B. Related Sections:
1. Section 312213 - Rough Grading.

1.2 SUBMITTALS

A. Section 013000 - Submittals: Requirements for submittals.

1.3 QUALITY ASSURANCE

A. Conform to applicable code for environmental requirements and disposal of debris.

PART 2 – PRODUCTS Not Used.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 017116 – Project Coordination: Verification of existing conditions before starting work.

B. Verify existing plant life designated to remain is tagged or identified.

3.2 PREPARATION

A. Call Local Utility Line Information service at 800-662-4111 not less than two working days before performing Work.
1. Request underground utilities to be located and marked within and surrounding construction areas.

3.3 PROTECTION

A. Locate, identify, and protect utilities indicated to remain, from damage.

B. Protect trees, plant growth, and features designated to remain, as final landscaping.

C. Protect bench marks, survey control points, and existing structures from damage or displacement.

3.4 REMOVAL

A. Remove debris, rock, and extracted plant life from site.

B. Partially remove paving, curbs, and, slabs as indicated on Drawings. Neatly saw cut edges at right angle to surface.

C. Remove abandoned utilities. Indicated removal termination point for underground utilities on Record Documents.

D. Continuously clean-up and remove waste materials from site. Do not allow materials to accumulate on site.

E. Do not burn or bury materials on site. Leave site in clean condition.

END OF SECTION

SECTION 312213 - ROUGH GRADING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Excavating subsoil.
2. Cutting, grading, filling, rough contouring, compacting, site for site structures, building pads, drainage and pavement.

B. Related Sections:
1. Section 310513 - Soils.
2. Section 310516 - Aggregate.
3. Section 311000 - Site Clearing: Excavating topsoil.
4. Section 312300 - Excavation and Fill: Building excavation.
5. Section 312323.13 - Backfill: General building area backfilling.
6. Section 312333 - Trenching: Trenching and backfilling for utilities.

1.2 REFERENCES

A. ASTM International:
1. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
2. ASTM D1557 - Standard Test Method for Laboratory Compaction Characteristics Of Soil Using Modified Effort (6,000 ft-lbf/ft3 (2,700 kN-m/m3)).
3. ASTM D2434 - Standard Test Method for Permeability of Granular Soils (Constant Head).
4. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
5. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

1.3 SUBMITTALS

A. Section 013000 - Submittals: Requirements for submittals.

B. Materials Source: Submit name of imported materials suppliers.

C. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

A. Section 017000 – Project Closeout: Requirements for submittals.

B. Project Record Documents: Accurately record actual locations of utilities remaining by horizontal dimensions, elevations or inverts, and slope gradients.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with ASTM C136, ASTM D2419, and ASTM D2434.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Subsoil Fill: Type S1 as specified in Section 310512.

B. Structural Fill: Type S1 A2 A4 as specified in Section 310512, 310516.

C. Granular Fill: Type A1 A2 A3 A4 A5 as specified in Section 312323.13.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 013113 – Project Coordination: Verification of existing conditions before starting work.

B. Verify site conditions under provisions of Section 017100

C. Verify survey bench mark and intended elevations for the Work are as indicated on Drawings.

3.2 PREPARATION

A. Call Local Utility Line Information service at 800 662-4111 not less than two working days before performing Work.
   1. Request underground utilities to be located and marked within and surrounding construction areas.

B. Identify required lines, levels, contours, and datum.

C. Protect utilities indicated to remain from damage.

D. Protect bench marks, survey control point, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.

3.3 SUBSOIL EXCAVATION

A. Excavate subsoil from areas to be further excavated, relandscaped, or regraded.

B. Do not excavate wet subsoil.

C. When excavating through roots, perform Work by hand and cut roots with sharp axe.

D. Remove excess subsoil not intended for reuse, from site.

3.4 FILLING

A. Fill areas to contours and elevations with unfrozen materials.

B. Place fill material in continuous layers and compact in accordance with schedule at end of this section.

C. Place material in continuous layers as follows:

1. Subsoil Fill: Maximum 8 inches compacted depth. 95% max density.
2. Structural Fill: Maximum 8 inches compacted depth. 95% max density.
3. Granular Fill: Maximum 8 inches compacted depth. 95% max density.

D. Maintain optimum moisture content of fill materials to attain required compaction density.

E. Slope grade away from building minimum 2 inches in 10 ft, unless noted otherwise.

F. Make grade changes gradual. Blend slope into level areas.

G. Repair or replace items indicated to remain damaged by excavation or filling.

3.5 TOLERANCES

A. Section 014500 - Quality Control Services: Tolerances.

B. Top Surface of Subgrade: Plus or minus 1/10 foot from required elevation.

3.6 FIELD QUALITY CONTROL

A. Section 014500 - Quality Control Services: Testing and inspection services.

B. Perform laboratory material tests in accordance with ASTM D1557.

C. Perform in place compaction tests in accordance with the following:
1. Density Tests: or ASTM D2922.
2. Moisture Tests: ASTM D3017.

D. When tests indicate Work does not meet specified requirements, remove Work, replace and retest.

E. Frequency of Tests: Pavement and Slabs - 1 test per lift per 1000 square feet
Trenches - 1 test mid and top trench per 100 feet of trench.

END OF SECTION

SECTION 312216 - STRUCTURAL SOIL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Work includes providing, installing, and compacting structural soil to be used as a structural base for paved areas adjacent to tree planting areas as shown on the drawings.

B. Related Sections include the following:

1. Division 31 - Earthwork
2. Section 321313 – Concrete Paving
3. Section 329000 – Planting

1.3 SUBMITTALS

A. At least 30 days prior to ordering materials, the Contractor shall submit to the Landscape Architect representative samples, certifications, manufacturer's literature and certified test results for all materials as specified below. No materials shall be ordered or delivered until the required submittals have been reviewed and stamped approved by the Landscape Architect. Delivered materials shall match the approved samples.

B. Approval shall not constitute final acceptance. The Landscape Architect reserves the right to reject, on or after delivery, any material that does not meet these Specifications.

C. List of submittals required.

1. Product date for Structural Soil
2. Sample of Structural Soil.

1.4 QUALITY ASSURANCE

A. The following standards apply to the work of this Section:

1. AOAC: Association of Official Agricultural Chemists.

2. ASA: Methods of Soils Analysis, American Society of Agronomy, Soil Science Society of America, Inc., Madison Wisconsin, latest edition.
3. American Society for Testing and Materials (ASTM).
4. All applicable local codes and regulations.

B. It is the intent of this specification that all materials herein specified and shown on the drawings shall be of the highest quality available and meeting the requirements specified.

C. The work of this Section shall be performed by a Contracting firm that has successfully installed work of a similar quality, schedule requirement, and construction detailing with a minimum of five (5) years experience.

D. All work shall be performed in accordance with the best standards of practice relating to the trade and under the continuous supervision of a competent foreman capable of interpreting the Drawing and Specifications.

E. Soil shall not be worked when moisture content is so great that excessive compaction occurs, nor when it is so dry, that dust will form in air or that clods will not break readily. Water shall be applied, if necessary, to provide ideal moisture content for tilling and for planting.

F. All accumulated debris and rubbish shall be cleaned up and removed from the site before commencing work. Clear and grub all dead vegetative matter. The site shall be weed free prior to proceeding with any work.

1.5 JOB CONDITIONS

A. Examine the subgrade, verify the elevations to be no more than plus or minus 2” above or below subgrade elevation which should allow for the depths required for topsoil and mulch throughout the planted areas. Observe the conditions under which work is to be performed, and notify the Landscape Architect of unsatisfactory conditions.

1.6 TESTING

A. Field in-place density tests shall be performed according to ASTM D 6938, ASTM D 1556, ASTM D 2167, or ASTM D 2937, as applicable. Testing laboratory shall submit test results directly to the Owner’s Authorized Representative for review and acceptance.

1. Structural Soil Areas: At each compacted fill and backfill layer, perform at least one field in-place density test for every 1,000 sq. ft. or less of structural soil area, but in no case fewer than three tests as directed by the Owner’s Authorized Representative.

PART 2 - PRODUCTS

2.1 STRUCTURAL SOIL

A. Structural Soil: Shall be Utelite Structural Soil as manufactured and distributed by Utelite Corporation. Contact: Scott Jenson, (801) 243-9348

1. The Contractor shall provide Structural Soil at locations and depths indicated on the Drawings to complete all indicated planting areas, as specified in this Section and as directed by the Landscape Architect.

PART 3 - EXECUTION

3.1 GENERAL

A. The paving contractor shall obtain necessary approvals before placing each Structural Soil Mix layer.

B. The paving contractor shall use adequate numbers of skilled workmen who are thoroughly trained in the necessary crafts and are completely familiar with the specified requirements and methods needed for proper performance of the work in this section.

C. Adequacy of the final compaction of all elements requiring compaction shall be verified by specified field testing and as determined in the field by the engineer to achieve the minimum specified compaction level.

3.2 PREPARATION

A. Remove all organic matter, debris, loose material and large rocks.

B. Dig out soft and mucky spots and replace with suitable material.

C. Loosen hard spots and uniformly compact the subgrade to 95% of its maximum dry density.

3.3 PLACING STUCTURAL SOIL

A. **IMPORTANT**: the trees must be planted after pavement is placed.

B. Adequacy of final compaction shall be shall be verified by specified field testing and as determined in the field by engineer using proof roll.

C. The structural soil mix shall be placed in approximately uniform lifts over the entire area of project and each lift compacted to 95%, including the open tree pit areas. Construction equipment, other than for compaction, shall not operate on the exposed structural soil mix. Over-compaction should be avoided. No foot or equipment traffic should be allowed on the compacted material until the paving is placed.

D. Use of a portable vibratory plate compaction machine (recommended).

E. Place structural soil mix in horizontal lifts not exceeding 8 inches of compacted depth. Use a minimum of two passes, of not less than 10 seconds per pass, before moving the vibratory plate to the next adjacent location. Additional passes may be required to achieve specified compaction and should be determined as necessary by testing to insure stability of the layer. Continue placing and compacting 8" lifts until the specified depth is reached as detailed.

3.4 CONCRETE PAVEMENT

A. See Section 321313 – Concrete Paving

3.5 TREE PLANTING

A. Tree Pit Excavation
   1. After the pavement is placed, excavate the structural soil mix to a depth equal to the height of the root ball of the tree to be planted. Remove the structural soil mix to within one foot of the edge of the paved area.
   2. Place the tree in the pit and backfill as soon as possible with Planting Soil Mix. Remove any excess soil on the top of the root ball that was filled above the root collar by the nursery. No tree pit shall remain excavated for more than 2 hours unless forms are used.

END OF SECTION 312216

SECTION 312300 - EXCAVATING, BACKFILLING, AND COMPACTION

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Preparation

B. Excavation

C. Backfilling

D. Compaction

E. Dewatering

F. Field Quality Control

G. Cleaning Up

1.02 QUALITY ASSURANCE

A. Comply with federal, state, and local codes and regulations.

B. All working conditions shall be in accordance with the "Utah Occupational Safety and Health Division", Safe Practices for Excavation & Trenching Operations, latest edition, or other Laws or Regulations which apply.

1.03 REFERENCES

A. Utah Occupational Safety and Health Division (UOSHD).

B. American Association of State Highway and Transportation Officials (AASHTO):

1. Designation T-99
2. Designation T-180

C. American Society for Testing and Materials (ASTM)

1. ASTM D-698
2. ASTM D-1557

1.04 QUALITY ASSURANCE

A. Cedar City requirements shall govern for all work in City right-of-ways:

1. All work shall conform to the applicable standards, regulations, and requirements of Cedar City.

2. Permits shall be obtained and paid for by the Contractor.
3. License and Permit Bond, without cancellation clause, in an amount and form prescribed by Cedar City, shall be provided by the Contractor in connection with his excavations and improvements in the City right of way.

PART 2 PRODUCTS

2.01 FOUNDATION MATERIALS

A. All foundation materials shall be free from alkali, salt, and petroleum products, roots, sod, limbs, and other vegetative matter, slag, cinders, ashes and rubbish, or other material that in the opinion of the Soils Engineer may be objectionable or deleterious.

B. Undisturbed soil foundation material:

1. Shall be natural trench bottom soil unless unable to adequately support pipe or structures.
2. Shall not be lumpy or frozen.

C. Gravel:

1. Shall be hard, durable, broken stone or slag.
2. Shall be graded within the following limits:

Sieve Size	Percent Passing By Weight
1"	100
3/4"	85-100
1/2"	20-40
#4	10-20

D. The recommendations of the soils engineer for gradations shall take precedence over typical gradations found herein.

2.02 BEDDING MATERIALS

A. Sand Bedding Material:

1. Shall be free from alkali, salt, and petroleum products, roots, sod, limbs, and other vegetative matter, slag, cinders, ashes and rubbish, or other material that in the opinion of the Soils Engineer may be objectionable or deleterious.
2. Graded within the following limits:

Seive Size	Percent Passing by Weight
3/4"	100
#4	80-100
#10	30-50
#40	10-30

#200	0-15

3. The recommendations of the soil's engineer for gradations shall take precedence over typical gradations found herein.

2.03 BACKFILL MATERIALS

A. Granular backfill:

1. Shall be readily compactable and shall be free from alkali, salt, and petroleum products, roots, sod, limbs, and other vegetative matter, slag, cinders, ashes and rubbish, or other material that in the opinion of the Soils Engineer may be objectionable or deleterious.
2. Graded within the following limits:

Seive Size	Percent Passing by Weight
3 inch	100
No. 10	50 max.
No. 40	30 max.
No. 200	15 max.

3. May be select material from excavation if it will meet all requirements of granular backfill, including compaction requirements as specified for type of surface improvement above trench.
4. The recommendations of the soil's engineer for gradations shall take precedence over typical gradations found herein.

C. Excavated Soil Backfill Material:

1. Shall be free from alkali, salt, and petroleum products, roots, sod, limbs, and other vegetative matter, slag, cinders, ashes and rubbish, or other material that in the opinion of the Soils Engineer may be objectionable or deleterious.
2. Shall be select material from excavation, with no particle larger than 4 inches in diameter.
3. Use on-site materials only if specified compaction requirements can be met.

PART 3 EXECUTION

3.01 PREPARATION

A. It shall be the Contractor's sole responsibility to locate all (whether or not shown on the Drawings) existing water, sanitary sewer, storm drain, and gas lines, electrical and telephone conduit and other underground utilities with their existing house service connections, and all other underground structures in order that no damage or loss of service will result from interference with existing lines.

B. Review all available drawings, notes, and information on the location of these underground lines and structures in determining the location of the existing facilities.

C. Have an electronic pipe finder on the job at all times and mark all lines on the road ahead of the excavating machine.

D. Blue Stakes Location Center shall be contacted 48 hours before any excavation is commenced. Phone 1-800-662-4111 for assistance.

E. Mark with paint any existing cracks on concrete along which work will take place, in order to determine after the construction is completed whether such damage was caused by the operations of the Contractor or had occurred previously. Any concrete showing unmarked cracks upon completion of construction will be evidence of damage by the Contractor's forces, and shall be replaced or repaired to the satisfaction of the Owner of the damaged concrete, at the Contractor's own expense.

F. All fences removed for excavation shall be returned to their original condition except that damaged portions will be replaced with new fencing at the Contractor's expense.

G. Obtain all required permits.

3.02 EXCAVATION

A. All gas, sanitary sewer, storm drain, water and other pipelines, flumes and ditches of metal, wood or concrete, underground electrical conduits and telephone cable, and all walks, curbs, and other improvements encountered in excavating trenches carefully shall be supported, maintained and protected from injury or interruption of service until backfill is complete and settlement has taken place.

B. If any existing facility is damaged or interrupted, promptly after becoming aware thereof and before performing any Work affected thereby, identify the owner of such existing facility, and give written notice thereof to that owner and the Owner and Engineer. Indemnify the Owner from any and all damages resulting from damaged facilities.

C. Excavation for pipe lines, concrete valve boxes, manholes and appurtenant structures shall include the work of removing all earth, sand, gravel, quicksand, stone, loose rock, solid rock, clay, shale, cement, hardpan, boulders, and all other materials necessary to be moved in excavating the trench for the pipe; maintaining the excavation by shoring, bracing, and sheeting or well pointing to prevent the sides of the trench from caving in while pipe laying is in progress; and removing sheeting from the trench after pipe has been laid.

D. Trench support system shall be suitable for the soil structure, depth of cut, water content of soil, weather conditions, superimposed loads, vibration. Contractor may select one of the following methods of ensuring the safety of workers in the trench, as approved by the Utah State Industrial Commission or its safety inspectors:

1. Sloping sides of trench to the angle of repose at which the soil will remain safely at rest.

2. Shoring trench sides by placing sheeting, timber shores, trench jacks, bracing, piles, or other materials to resist pressures surrounding the excavation.

3. Using a movable trench box built-up of steel plates and a heavy steel frame of sufficient strength to resist the pressures surrounding the excavation.

E. All damage, injury or loss resulting from lack of adequate sheeting, bracing, and shoring shall be the responsibility of the Contractor; and the Contractor shall effect all necessary repairs or reconstruction resulting from such damage.

F. Trenches shall be of the necessary width for proper laying of pipe. Care shall be taken not to over-excavate. The bottom of the trenches shall be accurately graded to provide uniform bearing and support for each section of the pipe along the entire length of the barrel of the pipe.

G. Trenches shall be excavated to the depths shown on the Drawings, including any required allowances for the sewer rock foundation, when required, and for other pipe bedding requirements.

H. Excess materials shall be hauled away from the construction site or otherwise disposed of by the Contractor as approved by the Engineer.

3.03 BACKFILLING

A. The trenches shall not be backfilled until the utilities systems as installed conform to the requirements of the Drawings and Specifications. Where, in the opinion of the Engineer, damage is likely to result from withdrawing sheeting, the sheeting shall be left in place.

B. Trenches shall be backfilled to the proper surface with material as shown or specified. Trenches improperly backfilled shall be reopened to the depth required for correction, then refilled and compacted as specified, or the condition shall be otherwise corrected as approved.

C. Materials for trench backfill shall be as shown on the Drawings or in the soils report

D. Each lift shall be evenly spread and moistened or dried by disk harrowing or other means so that the required density will be produced.

E. Backfill around valves with Granular Backfill Material.

F. Care shall be exercised so that when backfilling is complete and settlement has taken place, all existing pipes, flumes, ditches, conduits, cables, walks, curbs, and other improvements will be on the same alignment and grade as they were before work commenced.

3.04 COMPACTION

A. Compaction shall be the responsibility of the Contractor. He shall select the methods to be used and carefully perform the work of backfilling and compaction so as to prevent damage to new or existing piping. Any new or existing piping damaged during the Contractor's work shall be replaced as directed by the Engineer with new piping.

B. Backfill Compaction Requirements:

1. Under pavements, or other surface improvements, the average density shall be 96% of laboratory maximum density with no individual test lower than 92% of the laboratory maximum density, as

determined by AASHTO Designation T-180, and as specified by the Soils Engineer(ASTM D-1557).

2. In shoulders and other unimproved areas, the average density shall be 90% of laboratory maximum density with no individual test lower than 86% of the laboratory maximum density,as determined by AASHTO Designation T-180 (ASTM D-1557).

C. Compaction shall be performed in strict accordance with the manufacturer's recommendations for each type of pipe.

D. Mechanical compaction: Shall be accomplished by the use of sheeps-foot rollers, pneumatic tire rollers, vibrating rollers, or other mechanical tampers of a size and type necessary to achieve the required degree of compaction.

3.05 DEWATERING

A. The Contractor shall do all pumping, shall build all drains and do all the work necessary to keep the trench and pipes free from water during the progress of the work.

B. In wet trenches, a channel shall be kept open along the side of the pipe for conducting the water to a sump hole, from which it shall be pumped out of the trench. No water shall be allowed to enter the pipe.

3.06 FIELD QUALITY CONTROL

A. The Owner shall employ a testing laboratory to perform field and laboratory density tests, except that the Contractor shall make such additional tests, at his expense, as deemed necessary by him to assure that the work of compaction is performed properly, determine any adjustments in compacting equipment, thickness of layers, moisture content and compactive or other effort necessary to obtain the specified minimum relative density. Provide access to the work and all men and machinery necessary to aid the testing laboratory personnel in performing field density tests or taking samples for laboratory tests. In general, tests and samples shall be made as the work proceeds.

B. The Owner shall have testing laboratory perform maximum density tests on materials to be compacted from samples submitted by Contractor taken from locations selected by the Soil's Engineer.

C. The Owner shall have testing laboratory perform <u>field density tests</u> of compacted backfill materials. The approximate location and number of such tests shall be as shown on the drawings, as described in the Bid Form, or as selected by the Soil's Engineer. Field density tests shall be taken as follows:

1. In planted or unimproved areas:
   (a) 18" above the top of the pipe
   (b) Finished grade
2. In streets, roads, parking lots or other paved areas:
   (a) 18" above the top of the pipe
   (b) 24" to 36" below the gravel road base
   (c) Gravel road base subgrade
   (d) Top of gravel road base
   (e) Top of bituminous surface course

D. Copies of test results prepared by the testing laboratory shall be transmitted to the Contractor at the same time they are transmitted to the Engineer.

E. Successful performance of compaction at the location of the field density test shall not relieve the Contractor of his responsibility to meet the specified density requirements for the complete project.

3.07 CLEANING UP

A. The roadway, parking areas, including shoulders, slopes, ditches, and borrow pits shall be smoothly trimmed, and shaped by machinery, or other satisfactory methods, to the lines, grades and cross-sections, as established, and shall be so maintained until accepted. Any surplus material not suitable for spreading on the project shall be disposed of as specified above.

END OF SECTION

SECTION 312316.13 - TRENCHING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Excavating trenches for utilities from 5 feet outside building to utility service.
2. Compacted fill from top of utility bedding to subgrade elevations.
3. Backfilling and compaction.

B. Related Sections:
1. Geotechnical Study.
2. Section 310513 - Soils.
3. Section 310516 - Aggregate.
4. Section 312213 - Rough Grading: Topsoil and subsoil removal from site surface.
5. Section 331116 - Site Water Distribution: Water piping and bedding from building to booster pump.
6. Section 333100 - Sanitary Sewer System: Sanitary sewer piping and bedding from building to Manhole/septic tank
7. Section 335100 - Natural Gas Distribution: Gas piping and bedding from building to storage tank.
8. Section 334100 - Storm Drainage: Storm sewer piping and bedding from building to drain outlet
9. Section 033000 - Cast-in-Place Concrete: Concrete materials.

1.2 REFERENCES

A. ASTM International:
1. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
2. ASTM D1557 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (6,000 ft-lbf/ft3 (2,700 kN-m/m3)).
3. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
4. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

1.3 DEFINITIONS

A. Utility: Any buried pipe, duct, conduit, or cable.

1.4 SUBMITTALS

A. Section 013000 - Submittals: Requirements for submittals.

B. Materials Source: Submit name of imported fill materials suppliers.

C. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.5 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.6 COORDINATION

A. Section 013113 – Project Coordination: Coordination and project conditions.

B. Verify Work associated with lower elevation utilities is complete before placing higher elevation utilities.

PART 2 - PRODUCTS

2.1 BEDDING MATERIALS

A. Type B1 - Pea Gravel: Natural stone; free of clay, shale, organic matter; graded in accordance with ANSI/ASTM C136, to the following:
1. Minimum Size: 1/4 inch
2. Maximum Size: 5/8 inch.

B. Type B2 - Sand: Natural river or bank sand; free of silt, clay, loam, friable or soluble materials, or organic matter; uniform in size with no material larger than 3/4".

2.2 FILL MATERIALS

A. Subsoil Fill: Type S1 as specified in Section 310513.

B. Structural Fill: Type S1 A2 A4 as specified in Section 310513, 310516.

C. Granular Fill: Type A1 A3 as specified in Section 310516.

PART 3 - EXECUTION

3.1 LINES AND GRADES

A. Lay pipes to lines and grades indicated on Drawings.
1. Architect/Engineer reserves right to make changes in lines, grades, and depths of utilities when changes are required for Project conditions.

B. Use laser-beam instrument with qualified operator to establish lines and grades.

3.2 PREPARATION

A. Call Local Utility Line Information service at 800 662-4111 not less than two working days before performing Work.
1. Request underground utilities to be located and marked within and surrounding construction areas.

B. Identify required lines, levels, contours, and datum locations.

C. Protect plant life, lawns, and other features remaining as portion of final landscaping.

D. Protect bench marks, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.

E. Maintain and protect above and below grade utilities indicated to remain.

F. Establish temporary traffic control and detours when trenching is performed in public right-of-way. Relocate controls and reroute traffic as required during progress of Work.

3.3 TRENCHING

A. Excavate subsoil required for utilities to utility service.

B. Remove lumped subsoil, boulders, and rock of 1/6 cubic yard and up in size, measured by volume.

C. Perform excavation within 36 inches of existing utility service in accordance with the utility's requirements.

D. Do not advance open trench more than 200 feet ahead of installed pipe.

E. Cut trenches 12" wider than the outer diameter of the utility. Remove water or materials that interfere with Work.

F. Excavate trenches to depth indicated on Drawings. Provide uniform and continuous bearing and support for bedding material and utilities.

G. Do not interfere with 45 degree bearing splay of foundations.

H. When Project conditions permit, slope side walls of excavation as OSHA requires. When side walls cannot be sloped, provide sheeting and shoring to protect excavation as specified in this section.

I. When subsurface materials at bottom of trench are loose or soft, excavate to greater depth as directed by Architect/Engineer until suitable material is encountered.

J. Cut out soft areas of subgrade not capable of compaction in place. Backfill with Fill Type A4 and compact to density equal to or greater than requirements for subsequent backfill material.

K. Trim excavation. Hand trim for bell and spigot pipe joints. Remove loose matter.

L. Correct areas over excavated areas with compacted backfill as specified for authorized excavation or replace with fill concrete as directed by Architect/Engineer.

M. Remove excess subsoil not intended for reuse, from site.

3.4 SHEETING AND SHORING

A. Sheet, shore, and brace excavations to prevent danger to persons, structures and adjacent properties and to prevent caving, erosion, and loss of surrounding subsoil.

B. Support trenches more than 5 feet deep excavated through unstable, loose, or soft material. Provide sheeting, shoring, bracing, or other protection to maintain stability of excavation.

C. Design sheeting and shoring to be removed at completion of excavation work.

D. Repair damage caused by failure of the sheeting, shoring, or bracing and for settlement of filled excavations or adjacent soil.

E. Repair damage to new and existing Work from settlement, water or earth pressure or other causes resulting from inadequate sheeting, shoring, or bracing.

3.5 BACKFILLING

A. Backfill trenches to contours and elevations with unfrozen fill materials.

B. Systematically backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen, or spongy subgrade surfaces.

C. Place material in continuous layers as follows:
1. Subsoil Fill: Maximum 8 inches compacted depth.
2. Structural Fill: Maximum 8 inches compacted depth.
3. Granular Fill: Maximum 8 inches compacted depth.

D. Employ placement method that does not disturb or damage, utilities in trench.

E. Maintain optimum moisture content of fill materials to attain required compaction density.

F. Do not leave more than 50 feet of trench open at end of working day.

G. Protect open trench to prevent danger to Owner.

3.6 TOLERANCES

A. Section 014500 - Quality Control Services: Tolerances.

B. Top Surface of Backfilling Under Paved Areas: Plus or minus 1 inch from required elevations.

C. Top Surface of General Backfilling: Plus or minus 1 inch from required elevations.

3.7 FIELD QUALITY CONTROL

A. Section 014500 - Quality Control Services: Testing and inspection services.

B. Perform laboratory material tests in accordance with ASTM D1557.

C. Perform in place compaction tests in accordance with the following:
1. Density Tests: or ASTM D2922.
2. Moisture Tests: ASTM D3017.

D. When tests indicate Work does not meet specified requirements, remove Work, replace, compact, and retest.

E. Frequency of Tests: 1 Test mid and top of trench every 100 feet.

3.8 PROTECTION OF FINISHED WORK

A. Section 017000 – Project Closeout: Protecting finished work.

B. Reshape and re-compact fills subjected to vehicular traffic during construction.

3.9 SCHEDULE

A. Storm, Sanitary Piping and Utilites:

1. Cover pipe and bedding with Fill Type S1,A4,A5: To subgrade elevation.
2. Compact uniformly to minimum 95 percent of maximum density.

END OF SECTION

SECTION 312500 - EROSION AND SEDIMENT CONTROL

PART 1 GENERAL

1.1 SECTION INCLUDES

A. The work of this Section shall consist of providing all labor equipment, materials, incidental work, and construction methods necessary to provide and install erosion and sediment control, and related items as indicated on the Contract Documents and/or specified herein and includes but is not limited to the following:

1. Silt fencing
2. Protection of Drainage Structures
3. Straw Bales
4. Meeting all conditions for erosion control specified in these Specifications.

B. This Section specifies equipment and materials for an erosion and sediment control program for minimizing erosion and siltation during the construction phase of the Project. The erosion and sediment control provisions detailed on the Contract Documents and specified herein are the minimum requirements for an erosion control program. The Contractor shall provide additional erosion and sediment control materials and methods as required to affect the erosion and siltation control principles specified herein and comply with local and state requirements.

1.2 RELATED SECTIONS

A. Division 1 General
B. Specification Section 312000 - Earthwork.

1.3 REFERENCES

A. The following standards shall apply to the work of this Section.

1. American Society for Testing and Materials (ASTM):

a. D 3786 Test Method for Hydraulic Bursting Strength of Knitted Goods and Nonwoven Fabrics: Diaphragm Bursting Strength Tester Method.
b. D 4491 Test Method for Water Permeability of Geotextiles by Permittivity.
c. D 4751 Test Method for Determining the Apparent Opening Size of a Geotextile.
d. D 4833 Test Method for Index Puncture of Geotextiles, Geomembranes, and Related Products.

1.4 SUBMITTALS

A. Proposed methods, materials to be employed, and schedule for effecting erosion and siltation control and preventing erosion damage shall be submitted by the Contractor for approval to the Owner's Authorized Representative. Submittals shall include:

1. Proposed methods for effecting erosion and siltation control including 1 in. = 50 ft. scale plans indicating location of erosion control devices and siltation basins.
2. List of proposed materials including manufacturer's product data.
3. Schedule of erosion control program indicating specific dates for implementing programs in each major area of work.

1.5 PERMITS, CODES, AND REGULATIONS

A. The Contractor shall comply with all rules, regulations, laws and ordinances of the City, County, State, and all other authorities having jurisdiction over the Project site. The Contractor shall provide all labor, materials, equipment, and services necessary to make the work comply with such requirements without additional cost to the Owner.

B. Comply with the most stringent provisions of all applicable regulations of the State of Utah; the Army Corps of Engineers (ACOE); and the United States Environmental Protection Agency (EPA).

1.6 EROSION CONTROL PRINCIPLES

A. The Contractor shall provide suitable and adequate means of sedimentation and erosion control during construction. Control measures shall prevent all wind and water caused erosion, siltation and sedimentation of stockpiled materials, wetlands, waterways, construction areas, adjacent areas and off-site areas. Work shall be accomplished adjacent to or in the following work areas:

1. Soil stockpiles and on-site storage and staging areas.
2. Cut and fill slopes and other stripped and graded areas.
3. Constructed and existing swales and ditches.
4. Adjacent to wetlands or other protected areas as shown on the Contract Documents.

B. Means of protection as noted on the Contract Documents indicate the minimum provisions necessary. Additional means of protection shall be provided by the Contractor as required for continued or unforeseen erosion problems, at no additional expense to the Owner.

C. Regular maintenance of all sediment control structures shall be provided to ensure intended purpose is accomplished. Sediment control measures shall be in working condition at the end of each day.

D. After significant rainfall, sediment control structures shall be inspected for integrity. Any and all damaged devices shall be repaired immediately.

E. The following erosion control principles shall apply to the land grading and construction phases:

1. Contractor shall perform the work in a manner that will minimize soil erosion. Erosion control devices shall be installed prior to start of any and all clearing and grubbing operations and excavation work.
2. Contractor shall use temporary seeding, mulching, or other approved stabilization measures to protect exposed areas during prolonged construction or other land disturbance.
3. Contractor shall install drainage provisions that will accommodate increased runoff that results from modifications of soil and surface conditions during and after disturbance. Such provisions shall be in addition to existing requirements and shall be installed at no additional cost to the Owner.
4. Contractor shall retain all sediment on-site.

F. Cut and fill slopes and stockpiled materials shall be protected to prevent wind and water caused erosion. Slopes shall be protected with permanent erosion protection when erosion exposure period is expected to be greater than or equal to one month and temporary erosion protection when erosion exposure period is expected to be less than one month.

1. Erosion protection shall be accomplished by seeding with grass and coverings approved by the Owner's Authorized Representative.
2. Temporary erosion protection shall be accomplished by covering the exposed soil with an erosion protection material, as appropriate for prevailing conditions and as approved by the Owner's Authorized Representative.
3. Except where specified slope is indicated on Contract Documents, fill slopes shall be limited to a grade of 3:1 (horizontal: vertical) cut slopes shall be limited to a grade of 2:1.

PART 2 PRODUCTS

2.1 EROSION AND SEDIMENTATION CONTROL MATERIALS - GENERAL

A. Provide straw bales, silt fence and other materials in accordance with accepted Best Management Practices as required to prevent siltation and erosion. Contractor shall install, maintain and remove erosion control materials as required by the Owner's Authorized Representative.

2.2 SILT FENCE

A. Silt fence shall consist of 4 ft. hardwood stakes and filter fabric.

1. Filter fabric shall be woven geotextile fabric.
2. Provide filter fabric with integral plastic net backing for reinforced support and a tensioning belt to secure fabric to posts.
3. The filter fabric shall be Mirafi Envirofence as manufactured by TC Mirafi, 365 South Holland Drive, Pendergrass, GA 30567, (888) 795-0808; or approved equal.

4. Provide 2 in. x 2 in. by 4 ft. long hardwood stakes to support filter fabric.

2.3 BALES

A. Bales for construction of erosion control devices shall be new, firm, wire-or nylon-bound straw. Straw shall be from threshed grain free of seed and seed heads.

B. Provide two (2) 1 in. x 1 in. by 3 ft. hardwood stakes or steel reinforcing bars of minimum No. 4 size to secure bales.

2.4 MISCELLANEOUS ITEMS

A. Crushed stone shall be durable, crushed stone from off-site sources, conforming to the following: largest dimension no greater than 3/4 in.

B. 2”-4” Coarse Aggregate for Washdown/Road Stabilization - shall be durable, crushed stone from existing material on-site or off-site sources.

PART 3 EXECUTION

3.1 SILT FENCE

A. Silt fence shall be constructed and installed as indicated on the Contract Documents and as required by all governing agencies, prior to start of clearing and grubbing operations or any earthwork operations.

3.2 STRAW BALE DIKE

A. Straw Bale Installation

1. Bales shall be placed in a row with ends tightly abutting the adjacent bales.
2. Each bale shall be embedded in the soil a minimum of 4 in.
3. Bales shall be securely anchored in place by stakes or re-bars driven through the bales and driven a minimum 18 in. into the soil. The first stake in each bale shall be angled toward the previously laid bale to force the bales together.

B. Inspection shall be frequent and repair or replacement shall be made promptly as needed.

C. Bales shall be removed when they have served their usefulness so as not to block or impede storm flow or drainage. Bales that have deteriorated due to weather conditions shall be replaced.

3.3 STRAW BALE CHECK DAM

A. Check dams shall be constructed and installed as required by site conditions.

3.4 DRAINAGE STRUCTURE SEDIMENT TRAP

A. Drainage structure filters and sediment traps shall be placed at all inlets to drainage structures as detailed. Outlet protection work shall be constructed before runoff is allowed to enter the drainage system.

3.5 MAINTENANCE AND REMOVAL OF EROSION CONTROL DEVICES

A. Erosion control devises shall include silt fence, straw bales, crushed stone or gravel sock filters installed in combination or installed separately.

B. Culverts and drainage ditches shall be kept clean and clear of obstructions during construction period.

C. Erosion Control Devices

1. Sediment behind the erosion control device shall be checked twice each month and after each heavy rain. Silt shall be removed if greater than 6 in. deep.
2. Condition of erosion control device shall be checked twice each month or more frequently as required. Damaged and/or deteriorated items shall be replaced. Erosion control devices shall be maintained in place and in effective condition.
3. Straw bales shall be inspected frequently and maintained or replaced as required to maintain both their effectiveness and essentially their original condition. Underside of bales shall be kept in close contact with the earth below at all times, as required to prevent water from washing beneath bales.
4. Sediment shall be removed from the detention ponds at the completion of the Project and periodically during construction. Sediment deposits shall be removed when sediment has accumulated to a depth of 12 in. or as directed.
5. Sediment deposits shall be disposed of off-site, in a location and manner that will not cause sediment nuisance elsewhere.

E. Removal of Erosion Control Devices: Erosion control devices shall be maintained until all disturbed earth has been paved or vegetated, at which time they shall be removed.

1. Erosion protection material shall be kept securely anchored and in place until the acceptance the finished slope.
2. All bales and anchoring stakes, silt fencing, and all other temporary erosion control devices and accessories shall be completely removed at completion of project and legally disposed of off site at no additional cost to the Owner.
3. After erosion control devices are removed, areas disturbed by these devices the adjacent lawns or plantings.

END OF SECTION 312500

SECTION 320513 - SOILS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Subsoil materials.
   2. Topsoil materials.

B. Related Sections:
   1. Geotechnical Study.
   2. Section 320516 - Aggregate.
   3. Section 312213 - Rough Grading.
   4. Section 312323 - Backfill.
   5. Section 312333 - Trenching.
   6. Section 312313 - Subgrade preparation.

1.2 REFERENCES

A. American Association of State Highway and Transportation Officials:
   1. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.

B. ASTM International:
   1. ASTM D1557 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (6,000 ft-lbf/ft3 (2,700 kN-m/m3)).
   2. ASTM D2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).

1.3 SUBMITTALS

A. Section 013000 - Submittals: Requirements for submittals.
B. Materials Source: Submit name of imported materials source.
C. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.4 QUALITY ASSURANCE

A. Furnish each subsoil material from single source throughout the Work.

PART 2 – PRODUCTS

2.1 SUBSOIL MATERIALS

A. Subsoil Type S1:
   1. Excavated and re-used material.
   2. Graded.
   3. Free of lumps larger than 3 inches, rocks larger than 2 inches, and debris.
   4. Conforming to ASTM D2487 Group Symbol GP.

2.2 SOURCE QUALITY CONTROL

A. Section 014500 - Quality Control Services: Testing and Inspection Services Testing and analysis of soil material.
B. Testing and Analysis of Subsoil Material: Perform in accordance with ASTM D1557.
C. Testing and Analysis of Topsoil Material: Perform in accordance with ASTM D1557.
D. When tests indicate materials do not meet specified requirements, change material and retest.
E. Furnish materials of each type from same source throughout the Work.

PART 3 – EXECUTION

3.1 EXCAVATION
A. Excavate subsoil from areas designated. Strip topsoil to full depth of topsoil in designated areas.
B. Stockpile excavated material meeting requirements for subsoil materials.
C. Remove excess excavated materials not intended for reuse, from site.
D. Remove excavated materials not meeting requirements for subsoil materials from site.

3.2 STOCKPILING
A. Stockpile materials on site at locations designated by Architect/Engineer in coordination with the Owner.
B. Stockpile in sufficient quantities to meet Project schedule and requirements.
C. Separate differing materials with dividers or stockpile apart to prevent mixing.
D. Stockpile topsoil 8 feet high maximum.
E. Prevent intermixing of soil types or contamination.
F. Direct surface water away from stockpile site to prevent erosion or deterioration of materials.
G. Stockpile unsuitable or hazardous materials on impervious material and cover to prevent erosion and leaching, until disposed of.

3.3 STOCKPILE CLEANUP
A. Remove stockpile, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.

END OF SECTION

SECTION 321123 - AGGREGATE BASE COURSES

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Subgrade preparation to lines and grades shown on the plan.

B. Place, grade and compact base and sub-base course materials.

C. Dust and surface water control.

1.2 RELATED WORK

A. Section 321216.16 – Asphalt Concrete Paving.

1.3 REFERENCES

A. American Society for Testing Materials (ASTM).

B. American Association of Safety and Highway Transportation Officials (AASHTO)

PART 2 - PRODUCTS

2.1 BASE COURSE MATERIAL

A. Granular base for Pavement Preparation:

1. Shall be untreated natural stone.
2. Shall not be lumpy or frozen.
3. Shall be free from noticeable concentrations of alkali, salt, shale, and petroleum products, all roots, sod, limbs, and other vegetative matter, slag, cinders, ashes and rubbish, or other material that, in the opinion of the Engineer, is objectional or deleterious.
4. Shall be graded within the following limits:

Sieve Size	Percent Passing By Weight
1”	100
½”	70 - 100
No. 4	41- 68
No. 16	21- 41
No. 40	10 - 27
No. 200	4 - 13

PART 3 - EXECUTION

3.1 PREPARATION OF SUBGRADE

A. Prior to placing base course materials, the subgrade shall be scarified to a depth of not less than 6”, moistened or dried to optimum moisture content, and compacted to at least 95% maximum Modified Proctor Density as determined in accordance with ASTM D1557 (AASHTO T-180), and shall be within 2% of optimum moisture content.

B. The subgrade shall then be proof rolled in the presence of the Engineer by passing loaded rubber-tired construction equipment uniformity over the surface at a constant rate. At least two (2) passes shall be made over all subgrade areas.

C. If excessively soft, loose, or disturbed soils are encountered, they shall be removed as directed by the Engineer to a maximum depth of two feet (2') and replaced and recompacted to 95% maximum Modified Proctor Density using approved subgrade stabilizing material.

D. Ensure subgrade is to required lines and elevations.

3.2 PLACEMENT OF BASE COURSE

A. Protect against "pumping" moisture to surface by limiting travel on exposed subgrade. Where it is determined by the Owner that construction vehicle traffic (other than proof rolling) has caused subgrade instability, remove disturbed soils and replace with sand backfill at no additional cost to the Owner.

B. Apply water soluble herbicide for nonselective control of annual and perennial weeds in strict accordance with manufacturer's instructions and all laws and regulations.

C. Place base course material on the prepared and accepted subgrade. The material shall be back-dumped and spread in a uniform lift thickness.

D. Handle and spread materials in a manner that will prevent segregation of sizes. When vibrating or other acceptable types of compaction equipment are used, the entire course may be placed in one layer, provided the ability of the equipment to achieve specified compaction to the full layer depth is demonstrated. In no case shall compacted lift thickness be greater than 8".

E. When base course is constructed in more than one layer, the previously placed layer shall be cleaned of loose and foreign matter. Upper layer of base course shall not be less than 1-1/2", nor shall fine materials be added to reach final grade.

F. Overstressing the subgrade soil and base course shall be avoided by utilizing equipment in spreading and dumping that exerts only moderate pressure on the soil. Avoid excessive travel on lower base course lifts. Severe rutting, cracking or yielding is an indication of overstressing the soil. Any ruts or cracks which develop in the base course during spreading or compacting shall be repaired as directed at no additional cost to Owner.

G. Base course shall be compacted to no less than 95% maximum Modified Proctor Density, as determined by ASTM D1557 (AASHTO T-180). Moisture content shall be maintained to within 1.5% of optimum throughout placing and compaction operations.

1. Compaction shall always be commenced along the edge of the area to be compacted and the roller shall gradually advance toward the center of

the area to be compacted.

2. Compaction equipment shall be operated along lines parallel or concentric with the centerline of the road being constructed, and no material variation therefrom will be permitted.

H. Base course shall be substantially true to line and grade as indicated on the drawings. The surface shall be within ½" of required grade. Completed thickness of base course shall be within ½" of indicated thickness, with average thickness not less than that indicated.

I. The top surface of compacted base course shall be finished by blading or rolled with equipment designed for that purpose.

J. Temporary Graded Surface

1. When allowed by the local jurisdiction having authority, where trenches are excavated in paved traffic lanes, the surface course may be temporarily replaced by a surface consisting of base course material. The base course shall be removed and replaced with pavement as soon as conditions permit, or as required by local jurisdiction having authority.
2. The surface shall be maintained to provide for a smooth flow of traffic without holes, bumps, etc. until final acceptance of the work.

3.3 DUST AND SURFACE WATER CONTROL

A. Dust control measures shall be implemented by application of water to all work areas, storage areas, haul and access roads, or other areas affected by work.

B. All work shall be in compliance with the Federal, State and local air pollution standards, and not cause a hazard or nuisance to personnel and the public in the vicinity of the work.

C. Provide and operate at least one (1) mobile tank sprinkling unit during the contract period.

D. Other methods of dust control for hail and access roads may include chemical treatment, light bituminous treatment or other method as approved by the Owner.

E. Surface water shall be controlled to the extent that the areas to receive pavement, walks or slabs are not allowed to become wet from runoff from adjacent areas. Surface water shall be directed away from these areas but not directed toward adjacent property, buildings, or any improvement that may be amaged by water. Surface water shall not be allowed to enter sanitary sewers.

3.4 FIELD QUALITY CONTROL

A. Testing and inspection of placed Base Course will be provided by the Owner. Tests provided by the Owner are as follows:

Item	Type	Frequency
Base Course Aggregate Sampling	ASTM D75	Each day or 1 test/ 500 sq. yd., or as

		required.
Atterberg Limits	ASTM D2419, D423, and D424	As required
Sieve Analysis	ASTM C136	As required
Bearing Ratio	ASTM D1883	As required
Maximum Density	ASTM D1557, Method D	As required
In-place Density	ASTM D2167, D2922 and D3017	As required

B. If tests indicate that sub-base and/or base course do not meet specified requirements, remove defective work, replace and retest at no cost to Owner.

END OF SECTION 321123

SECTION 321216 – ASPHALTIC CONCRETE PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Cold milling of existing hot-mix asphalt pavement.
2. Hot-mix asphalt patching.
3. Hot-mix asphalt paving.
4. Hot-mix asphalt paving overlay.
5. Asphalt surface treatments.
6. Pavement-marking paint.
7. Traffic-calming devices.

B. Related Sections:

1. Division 2 Sections for other paving installed as part of crosswalks in asphalt pavement areas.
2. Division 2 Section "Building Demolition" for demolition, removal, and recycling of existing asphalt pavements, and for geotextiles that are not embedded within courses of asphalt paving.
3. Division 2 Section "Earthwork" for aggregate subbase and base courses and for aggregate pavement shoulders.
4. Division 2 Section "Pavement Joint Sealants" for joint sealants and fillers at paving terminations.

1.3 DEFINITION

A. Hot-Mix Asphalt Paving Terminology: Refer to ASTM D 8 for definitions of terms.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.
   1. Job-Mix Designs: For each job mix proposed for the Work.

B. Material Test Reports: For each paving material.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements: All paving shall be done according to the requirements of the UDOT Standard Specification for Road and Bridge Construction.

B. Manufacturer Qualifications: Shall meet the requirements of UDOT as mentioned above.

C. Installer Qualifications: Installer shall meet the installation requirements of UDOT as mentioned above.

D. Testing Agency Qualifications: by Owner.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver pavement-marking materials to Project site in original packages with seals unbroken and bearing manufacturer's labels containing brand name and type of material, date of manufacture, and directions for storage.

B. Store pavement-marking materials in a clean, dry, protected location within temperature range required by manufacturer. Protect stored materials from direct sunlight.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met:

1. Prime Coat: Minimum surface temperature of 50 deg F .
2. Tack Coat: Minimum surface temperature of 50 deg F .
3. Slurry Coat: Comply with weather limitations in ASTM D 3910.
4. Asphalt Base Course: Minimum surface temperature of 50 deg F and rising at time of placement.
5. Asphalt Surface Course: Minimum surface temperature of 50 deg F at time of placement.

B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 deg F for oil-based materials and 55 deg F for water-based materials, and not exceeding 95 deg F .

PART 2 - PRODUCTS

2.1 AGGREGATES

A. General: Use materials and gradations that have performed satisfactorily in previous installations.

B. Coarse Aggregate: ASTM D 692, sound; angular crushed stone, crushed gravel, or cured, crushed blast-furnace slag.

C. Fine Aggregate: ASTM D 1073, sharp-edged natural sand or sand prepared from stone, gravel, cured blast-furnace slag, or combinations thereof.

1. For hot-mix asphalt, limit natural sand to a maximum of 20 percent by weight of the total aggregate mass.

2.2 ASPHALT MATERIALS

A. Asphalt Binder: AASHTO M 320 or AASHTO MP 1a meeting the requirements of UDOT and SUU.

B. Asphalt Cement: ASTM D 3381 for viscosity-graded material ASTM D 946 for penetration-graded material.

C. Prime Coat: ASTM D 2027, medium-curing cutback asphalt, MC-70.

D. Prime Coat: Asphalt emulsion prime coat complying with UDOT requirements.

E. Tack Coat: emulsified asphalt, or cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.

F. Water: Potable.

G. Undersealing Asphalt: ASTM D 3141, pumping consistency.

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: Grade Nos. 2 or 3.

C. Pavement-Marking Paint: Alkyd-resin type, lead and chromate free, ready mixed, complying with AASHTO M 248; colors complying with FS TT-P-1952.

1. Color: As indicated.

2.4 MIXES

A. Hot-Mix Asphalt: 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: ASTM D 3515, 1-inch maximum aggregate size.
3. Surface Course: ASTM D 3515, 1/2 inch maximum aggregate size.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that subgrade is dry and in suitable condition to begin paving.

B. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction. Limit vehicle speed to 3 mph.
2. Proof roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Construction Manager or Owner, and replace with compacted backfill or fill as directed.

C. Proceed with paving only after unsatisfactory conditions have been corrected.

D. Verify that utilities, traffic loop detectors, and other items requiring a cut and installation beneath the asphalt surface have been completed and that asphalt surface has been repaired flush with adjacent asphalt prior to beginning installation of imprinted asphalt.

3.2 PATCHING

A. Hot-Mix Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.

B. Tack Coat: Apply uniformly to vertical surfaces abutting or projecting into new, hot-mix asphalt paving at a rate of 0.05 to 0.15 gal./sq. yd.

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.

C. Patching: Fill excavated pavements with hot-mix asphalt base mix for full thickness of patch and, while still hot, compact flush with adjacent surface.

D. Patching: 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.

3.3 REPAIRS

A. Leveling Course: Install and compact leveling course consisting of hot-mix asphalt surface course to level sags and fill depressions deeper than 1 inch in existing pavements.

1. Install leveling wedges in compacted lifts not exceeding 3 inches thick.

3.4 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.

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.

1. Mix herbicide with prime coat if formulated by manufacturer for that purpose.

C. Prime Coat: Apply uniformly over surface of compacted unbound-aggregate base course at a rate of 0.15 to 0.50 gal./sq. yd. Apply enough material to penetrate and seal but not flood surface. Allow prime coat to cure.

1. If prime coat is not entirely absorbed within 24 hours after application, spread sand over surface to blot excess asphalt. Use enough sand to prevent pickup under traffic. Remove loose sand by sweeping before pavement is placed and after volatiles have evaporated.
2. Protect primed substrate from damage until ready to receive paving.

D. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd.

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.

3.5 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.
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 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.

3.6 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.
3. Offset transverse joints, in successive courses, a minimum of 24 inches.
4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time.
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.

3.7 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 with vibratory-plate compactors in areas inaccessible to rollers.

1. Complete compaction before mix temperature cools to 185 deg F.

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 6927, but not less than 94 percent nor greater than 100 percent.
2. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent nor greater than 96 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.

3.8 INSTALLATION TOLERANCES

A. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:

1. Base Course: Plus or minus 1/2 inch.
2. Surface Course: Plus 1/4 inch, no minus.

B. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:

1. Base Course: 1/4 inch.
2. Surface Course: 1/8 inch.
3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch.

3.9 SURFACE TREATMENTS

A. Fog Seals: Apply fog seal at a rate of 0.10 to 0.15 gal./sq. yd. to existing asphalt pavement and allow to cure. With fine sand, lightly dust areas receiving excess fog seal.

B. Slurry Seals: Apply slurry coat in a uniform thickness according to ASTM D 3910 and allow to cure.

1. Roll slurry seal to remove ridges and provide a uniform, smooth surface.

3.10 PAVEMENT MARKING

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.

B. Allow paving to age for 30 days before starting pavement marking.

C. Sweep and clean surface to eliminate loose material and dust.

D. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

3.11 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

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. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement according to ASTM D 979.

1. Reference maximum theoretical density will be determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D 2041, and compacted according to job-mix specifications.
2. In-place density of compacted pavement will be determined by testing core samples according to ASTM D 1188 or ASTM D 2726.

   a. One core sample will be taken for every 1000 sq. yd. or less of installed pavement, with no fewer than 3 cores taken.

b. Field density of in-place compacted pavement may also be determined by nuclear method according to ASTM D 2950 and correlated with ASTM D 1188 or ASTM D 2726.

E. Replace and compact hot-mix asphalt where core tests were taken.

F. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.12 DISPOSAL

A. Except for material indicated to be recycled, remove excavated materials from Project site and legally dispose of them in an EPA-approved landfill.

1. Do not allow milled materials to accumulate on-site.

END OF SECTION 321216

SECTION 321312 – SITE SPECIALTY CONCRETE

PART 1 GENERAL

1.0 DESCRIPTION

A. The work to be performed under this section shall consist of furnishing all labor, materials, and equipment to form, pour, finish, and cure pedestrian concrete walks that will be mechanically **ground post curing to expose specialty black to dark grey aggregate**. Work also includes other site improvements as per the plans and specifications. The work may include but not be limited to excavation, forming, pouring, finishing, jointing, curing, protecting, removing forms, restoring earth or sod around the edges, and guaranteeing the work.

1.1 RELATED SECTIONS AND REQUIREMENTS

A. SEE GEO TECH REPORT

1.2 REFERENCES

A. American Public Works Association (APWA) Specifications:

1. Section 321123: Crushed Aggregate Base.
2. Section 312326: Compaction.
3. Section 033004: Concrete.
4. Section 032000: Concrete Reinforcing.
5. Section 033900: Concrete Curing.

1.3 SUBMITTALS

No materials shall be ordered or delivered until the required submittals have been reviewed and stamped approved by the Owner's Representative. Delivered materials shall match the approved samples. Approval shall not constitute final acceptance. The Owner's Representative reserves the right to reject, on or after delivery, any material that does not meet these Specifications.

A. See section 013000 – Administrative Requirements, for submittal procedures.

B. Aggregate: For colored aggregate types

C. Documentation: For qualifications of contractor to perform the work described.

D. Design Mixtures: For each concrete pavement mixture. Include alternate mixture designs when characteristics of materials, Project conditions, installation details, weather, test

results or other circumstances warrant adjustments.

B. Product Data: Manufacturer's data sheets on each product to be used, including:
1. Test Reports: PDF or 3 hardcopies from independent testing agency showing compliance with specified ASTM requirements.
2. Preparation instructions and recommendations.
3. Installation methods.

1.4 QUALITY ASSURANCE

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

B. ACI Publications: Comply with ACI 301, "Specifications for Structural Concrete," unless modified by requirements in the Contract Documents.
C. Manufacturer Qualifications:
D. Products shall be produced by a single manufacturer /quarry unless otherwise specified.
E. Installer Qualifications:
Subcontractor shall submit evidence of skill and not less than five years specialized experience with this product.
F. Mock-Up:
1. Provide a mock-up for evaluation of surface preparation techniques and application workmanship.
2. 10 feet by 10 feet at area designated by Architect or Landscape Architect.
3. Do not proceed with remaining work until workmanship, color, and sheen are approved by Architect or Landscape Architect.
4. Refinish mock-up area as required to produce acceptable work, mock up may remain as part of work if acceptable.
G. Pre-installation Meeting:
1. Hold a pre-installation conference, prior to start of installation. Attendees shall include Contractor, Architect, installer, Owner's Representative, and manufacturer's designated representative.
2. Review all related project requirements and submittals, status of substrate work and preparation, areas of potential conflict and interface, availability of stone pavers and components, installer's qualifications, equipment, and coordinate methods, procedures and sequencing requirements for full and proper installation, integration and protection.

1.5 SAMPLING AND TESTING

A. All concrete shall be sampled and tested in accordance with AASHTO Designation T-141 for air entrainment, slump, and strength. The Contractor shall have the test made at the appropriate times and places. All test results shall be sent to the project Owner's

Authorized Representative by the testing laboratory at the Contractors expense.

1. Slump Test: Slump tests shall be made in accordance with AASHTO Designation T-119. If a slump test does not meet the specifications, a second slump test shall be made immediately on the same load. The load will be accepted or rejected from the site by the inspector depending on the results of the second test. Perform one slump test for each set of test cylinders taken.

2. Air Entrainment: Air entrainment tests shall be made in accordance with AASHTO Designations T-152. If an air entrainment test does not meet the specification, a second test shall be taken immediately on the same load. The load will be accepted or rejected from the site by the Inspector depending on the results of the second test.

3. Compression Tests: Making, curing, and determining compressive strength of concrete cylinders shall be in accordance with AASHTO Designation T-22 and T23. For each test, mold and cure three test cylinders. Compressive strength shall be determined from "Strength Tests" in which the average of three standard cylinders shall constitute one strength test. Cylinders for strength tests shall be taken by the testing laboratory, which will also inspect the batching procedure to ascertain compliance with the mix design.

   a. Obtain test samples for every 100 cu yd or less of each class of concrete placed.
   b. Take one additional test cylinder during cold weather concreting, cured on job site under same conditions as concrete represents.
   c. If any individual strength test is below 4,000 PSI, the concrete may be accepted by the project Owner's Authorized Representative after reviewing the circumstances. The price the Owner shall pay for the concrete will be reduced in accordance with the following schedule:

PSI Below Specified Strength Specification	Pay Factor (Percent)
1-100	98
101-200	94
200-300	88
301-400	80

4. Proctor Tests: Compaction of the natural or imported base shall be tested in accordance with AASHTO Designation T-191. All testing procedures and any additional tests which may be required shall follow those specified in the most recent edition of State of Utah Standard Specifications for Road and Bridge

Construction.

B. All costs incurred in sampling and re-sampling, testing and retesting shall be paid by the Contractor.

C. All batching and mixing procedures shall be followed based upon the Salt Lake County Public Works Specifications as administered by the Salt Lake County Public Works Department as related to the most recent edition of the State of Utah Standard Specifications for Road and Bridge Construction

PART 2 MATERIALS

2.0 CONCRETE MATERIALS

A. Cement: The cement shall be Portland Type II cement meeting current AASHTO Designation M-85 Specifications. The supplier and type of cement shall not be changed during the complete concrete phase of the project. Supplement with the following:

1. Fly Ash: ASTM C 618, Class F, Sourced from Bridger Power Plant, Wyoming, or Navajo Power Plant, Arizona.

B. Aggregate: **Black or dark grey aggregate** shall be well graded from fine to coarse. The fine aggregate shall be uniformly graded meeting the requirements of AASHTO Designation ASTM-C33. The coarse aggregate shall be 1" to #4 conforming to the requirements of AASHTO Designation M-92.

C. Water: All water used in mixing the concrete shall be as per ASTM C94/C 94M.

D. Fill and Back Fill: The entire area beneath the concrete shall be excavated to the proper depth to allow for the specified thickness of untreated base course compacted to 95% as measured by a Procter test.

1. All excavated material shall be either re-used on the site or hauled away as specified on the plans.
2. Where untreated base course (free drainage material) is specified, the contractor shall import the required quantities from a local supplier. The contractor shall submit samples of the material to be used to the Inspector 3 days prior to use on the site. The untreated base course shall meet the requirements of Section 301 of the most recent edition of State of Utah Standard Specifications for Road and Bridge Construction. This refers to AASHTO Designations I-90, T-27, T-11, T-19 for mineral aggregate requirements. The gradation shall be for 3/4 or 1" maximum passing through the sieves in the percentages and with the tolerances

shown on page 108, section 301.03 of the State Standard Specifications referred to above. (Base material shall be installed 6" wider than concrete walk width, both sides.)

E. Air Entrainment Admixture: ASTM C260.

F. Chemical Admixtures: ASTM C494/C 494M, of type suitable for application, certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.

G. Concrete Sealer: Non-slip concrete sealer.

2.1 FORMS: Forms shall be of suitable materials such as wood, plastic, metal, or combinations thereof. Forms shall be of the shape and dimensions shown on the plans and true to line and grades specified. All forms shall be free from knotholes, loose knots, cracks, splints, warps, or other defects affecting the strength or appearance of the finished product. All forms shall be free of bulges and warping. They shall be cleaned thoroughly before they are used on this project. There shall be no split holes, bolts, or nuts on the final concrete surface when the forms are removed.

A. If at any stage of work, during or after placing the concrete, the forms sag or bulge the affected concrete shall be removed. Exceptions may be considered by the Inspector if the concrete is going to be covered with earth.

2.2 METAL REINFORCEMENT

A. Steel reinforcing bars: shall conform to ASTM A 615.

1. Bars employed as reinforcement shall be deformed type.
2. Bars employed as dowels shall be hot-rolled plain rounds.
3. Unless otherwise indicated on the Drawings, reinforcing bars shall be Grade 60.

B. Steel expansion dowels: conform to AASHTO M31.

1. Hot-rolled plain steel rounds.
2. Grade 60 - 1/2 inch by 24 inches (610 mm) smooth steel dowel and compatible waxed tube sleeve, 12 inches in length.
3. Dowels and sleeves shall be as furnished by U.S. Steel Corp., or approved equal.
4. Bars employed as dowels shall be hot-rolled plain rounds.
5. Dowels shall be epoxy coated.

2.3 CONCRETE MIXTURES

A. Prepare design mixtures, proportioned according to ACI 301, with the following properties:

1. All concrete shall be Class AA (AE) Type II.
2. Compressive Strength (28 days): 4,000 P.S.I.
3. 6.5 bag cement mix shall be used, with adjustments made as necessary due to the use of fly ash.
4. Fly Ash Content: Maximum 15% of cementitious materials by weight, subject to mix design verification
5. Water-Cement Ratio: .45 maximum water/cement ratio at point of placement, or as little water content as practicable.
6. Air Content: 6%, with a plus or minus variable of 1%.
7. Slump Limit: 4 inch maximum.
8. The supplier and mix of concrete shall not be changed during the complete concrete phase of the project.

2.5 RELATED MATERIALS

A. Expansion Joint Filler: ASTM D 1751, 1/2" thick, asphalt-saturated cellulosic fiber.
B. Sealant as specified below, or approved equal:
Sikaflex polyurethane based sealant: Manufacturer: Sika Corporation, 1-800-933-SIKA, for sealing control joints and expansion joints in concrete.
9. Expansion joints: Sikaflex 1a
10. Color sealant Limestone (color to match concrete)
11. Use primer recommended by the manufacturer for the use intended.

2.6 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth.

B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap polyethylene sheet.

C. Water: Potable.

D. Evaporation Retarder: Waterborne, monomolecular film forming; manufactured for application to fresh concrete.

E. Clear Waterborne Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating

F. White Waterborne Membrane-Forming Curing Compound: ASTM C 309, Type 2, Class

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify compacted base course is acceptable and ready to support paving and imposed loads.

B. Verify gradients and elevations of base are correct.

3.2 PREPARATION

A. Construct subgrades to plan elevations following Division 31 Earhthwork specification sections.

B. Place and compact fill material and untreated base course. Follow APWA Section 312326, Compaction.

C. Moisten base to minimize absorption of water from fresh concrete.

D. Coat surfaces of manhole frames with oil to prevent bond with concrete pavement.

E. Notify architect minimum 24 hours prior to commencement of concreting operations.

3.3 PLACEMENT (Supervisor/Foreman must have A.C.I. Training): All debris shall be removed from the inside of the forms prior to placement of any concrete. The Contractor shall take all necessary measures to protect the concrete after placement to prevent rain, graffiti, or other damage to the surface.

A. Concrete mix trucks shall be routed to each pour over areas where the least possible damage will occur to the existing sprinkler irrigation system, utilities, lawn, or plant materials. The Contractor shall be responsible for repair of damage done by the concrete mix trucks and any other vehicles involved in these operations.

B. The concrete shall be spread in horizontal layers insofar as practical and only of the thickness that can be satisfactorily hand worked or compacted with vibrators and other such equipment.

C. The concrete shall be deposited as near the final resting place as possible so as to

minimize working it and to prevent separating the ingredients.

D. The concrete slope shall be a minimum 1" per 10' or 1% in the direction of the natural grade or as indicated on the plans. Flat work will have not more than an 1/8" difference in a 20' radius.

3.4 COLD AND HOT WEATHER CONCRETING

A. Follow recommendations of ACI 305R when concreting during hot weather.

B. Follow recommendations of ACI 306R when concreting during cold weather.

C. Do not place concrete when base surface temperature is less than 40 degrees F, or surface is wet or frozen.

3.5 ADMIXTURES

A. Use medium-range water-reducing admixture as recommended by QA/QC testing laboratory and fly ash supplier to attain optimum durability and compliance with Owner's targeted LEED SS Credit 7.1 Heat Island Effect, Non-Roof, which requires SRI (albedo) of 29 or greater.

3.6 STEEL REINFORCEMENT

A. Reinforcing for reinforced concrete shall be thoroughly cleaned of loose mill and rust scale, dirt, ice, and other foreign material which may reduce the bond between the concrete and reinforcing. Where there is delay in placing concrete after reinforcement is in place, bars shall be re-inspected and cleaned when necessary.

B. Reinforcing Steel: After forms have been coated with form release agent, but before concrete is placed, reinforcing steel anchors shall be securely wired in the exact position called for, and shall be maintained in that position until concrete is placed and compacted.

1. Any bar showing cracks after bending shall be discarded.
2. Chair bars and supports shall be provided in a number and arrangement satisfactory to the Landscape Architect.

C. Unless otherwise indicated on the Drawings, reinforcing shall extend to within two (2) inches of formwork and expansion joints.

1. Reinforcing shall continue through control joints.

D. The Owner may do core testing to make sure that reinforcement is in the proper position. If testing shows otherwise, concrete will be rejected and the Contractor shall remove all

rejected slabs and re-pour new slabs at no additional cost. Contractor shall repair cored holes as directed by the Landscape Architect.

3.7 GROUND FINISH

A. Shall be ground to a minimum depth to expose the black to dark grey aggregate. Finish shall be even and uniform without low or high points varying more than 1/8". Concrete to be ground course enough to provide a non-skid surface, with troweled and radius edges ½" radius.

3.8 JOINTING

A. Joints shall be placed in the concrete by the Contractor so as to control and minimize cracking. Normally the Contractor shall follow the jointing patterns shown on the plans or submit a drawing showing recommended changes for approval by the project Owner's Authorized Representative or Landscape Architect.

1. Control Joints: Sidewalk joints shall be in linear feet equal to the width of the walk (for example, a 6-foot wide walk shall be scored every 6 linear feet.) unless otherwise noted on the plans Slab work shall be jointed a maximum in feet of 2 - 1/2 times the thickness of the concrete in inches (for example, the joints would be less than 15 feet apart for a slab 6 inches thick) and never more than 15 feet apart - for a 4" slab, between 8 - 10 feet.

   a. The control joints shall be a depth of 1/4 the thickness of the slab. Control joints shall be made before shrinkage cracking occurs. All control joints shall be continuous across the concrete except where interrupted by a post, wall, joint, or other obstacle.

   b. Control joints shall be saw cut (within 24 hours of pour), filled with an exterior weather sealant, and then a one part polyurethane sealant such as Chem-Calks 900. They may be hand formed with a deep cut wand tool with 1/4 radius round edges.

2. Construction Joints: Shall be created longitudinally by the edges of paving or transversely at the end of each days work. A key way shall be formed by fastening a key of wood, plastic, or PVC to the form of the first slab. The thickness of the key way shall be 1/5 of the thickness of the slab. The edges shall be rounded 1/4" radius, never on slabs less than 6" thick. Use a release agent on wood formed key ways.

3. Doweled joints: should be installed as detailed at all intersecting walks, where new concrete ties into existing concrete and at expansion joints in the concrete

drive and parking paving.

4. Expansion Joints: Shall be created at junctions of new and existing pavement, at buildings, or other abutting objects and where shown on the drawings. Expansion joints shall not be spaced greater than 50' apart. An 1/2" expansion joint material (full depth) shall be placed against the existing object to prevent bonding.

   a. Terminate joint filler not less than 1/2 inch or more than 1 inch below finished surface if joint sealant is indicated.
   b. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
   c. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
   d. Protect top edge of joint filler during concrete placement with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.
   e. Sealing Joints: Expansion joints in concrete walkways shall be sealed with a polyurethane joint sealant 3/8"depth.

3.9 CARE AND CURING

A. All concrete shall be cured for a minimum of 7 days before heavy loads may be placed upon it. Care shall be taken by the Supplier and the Contractor to prevent too rapid curing and the improper aging of the concrete. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

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

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

D. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these methods.

E. After pouring and during the curing process, the Contractor shall see that no initials or other unnecessary marks are made into the surface. The Contractor shall replace any section containing permanent marks at the completion of the project. Prior to that time, the Contractor may grind the surface or take measures to erase any permanent marks in a section if approved by the Inspector or Owner's Authorized Representative.

3.10 FORM REMOVAL

A. After the concrete is cured, all forms, stakes, and fastening materials shall be removed from the concrete. Care shall be taken to protect the edges from chipping and to prevent damage to the concrete during removal.

All forming materials shall be taken from the site as soon as possible after removal. The area taken up by the forms shall be filled with approved backfill, if needed, and compacted so that top soil shall be placed on top to meet finished grade. If the area is in existing lawn, the sod shall be removed back from the edges of the concrete the standard width of new commercial sod. Then new commercial sod shall be laid full width along the edges of the new concrete until all areas are repaired. The finish grade against the concrete shall be 1 to 2" below the top of the concrete.

3.11 PAVEMENT TOLERANCES

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

1. Elevation: 1/4 inch.
2. Thickness: minus ¼ inch.
3. Surface: Gap below 10-foot long, unleveled strait edge not to exceed ¼ inch.
4. Joint Spacing: 3 inches.
5. Contraction Joint Depth: Plus ¼”, no minus.
6. Joint width: Plus 1/8”, no minus.

3.12 CLEAN-UP

A. Upon completion of the concrete work, the entire affected area shall be cleaned up by the Contractor. All wood, forms, stakes, rocks, sod, and other extraneous material shall be removed from the premises.

3.13 PROTECTION, GUARANTEE AND REPLACEMENT

A. The Contractor shall guarantee all concrete materials, labor, and workmanship for 1 year following final approval of the contract as per the general County Specifications. Sections containing cracks deemed to be unacceptable by Owner’s Authorized Representative shall be replaced at no expense to the Owner.

B. Protect concrete from damage, Exclude traffic from pavement for at least 14 days after placement.

C. Maintain concrete free of stains, discolorations, dirt, and other foreign material. Sweep concrete pavement not more than two days before dated scheduled for Substantial

Completions inspection.

END OF SECTION 321312

SECTION 321400 - STONE PAVERS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. The work of this Section consists of providing all labor, materials, tools, incidental work, equipment and construction methods necessary to furnish and install designated Stone Pavers and related items as indicated on the Construction Documents, as specified in this Section, and includes, but is not limited to, the following:
1. Granite Pavers
2. Setting Sand
3. Untreated Base Coarse
4. Joint Filler
5. Paver Restraint Edge
6. Masonry Adhesive

1.2 RELATED SECTIONS

A. Section 329119 – Fine Grading.

B. Sections for Architectural and Civil sections for stairs, walls, drains, etc.

1.3 REFERENCES

A. American Society for Testing and Materials (ASTM): International (ASTM):
1) ASTM C 33 – Standard Specification for Concrete Aggregates.
2)ASTM C 97 – Standard Test Method for Absorption and Bulk Specific Gravity of Dimension Stone.
3)ASTM C 99 – Standard Test Method for Modulus of Rupture of Dimension Stone.
4)ASTM C 144 – Standard Specification for Aggregate for Masonry Mortar.
5)ASTM C 170 – Standard Test Method for Compressive Strength of Dimension Stone.
6)ASTM C 241 – Standard Test Method for Abrasion Resistance of Stone Subjected to Foot Traffic.
7)ASTM C 615 – Standard Specification for Granite Dimension Stone.
8)ASTM C 880 – Standard Test Method for Flexural Strength of Dimension Stone.
9)ASTM D 698 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort.
10)ASTM D 1557 – Standard Test Methods for Laboratory Compaction Characteristics of Soil using Modified Effort.
ASTM D 4491 – Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
11)ASTM D 4751 – Standard Test Method for Determining Apparent Opening

Size of a Geotextile. American Association of State Highway and Transportation Officials (AASHTO) M 288 – Standard Specification for Geotextile Specification for Highway Applications.
12)Masonry Standards Joint Committee (MSJC):
13)ACI 530.1/ASCE 6/TMS 602 – Specification for Masonry Structures; Cold and hot weather requirements for mortar and grout.

1.4 SUBMITTALS

A. No materials shall be ordered or delivered until the required submittals have been reviewed and stamped approved by the Owner's Representative. Delivered materials shall match the approved samples. Approval shall not constitute final acceptance. The Owner's Representative reserves the right to reject, on or after delivery, any material that does not meet these Specifications.

B. Product Data: Manufacturer's data sheets on each product to be used, including:
   1. Test Reports: PDF or 3 hardcopies from independent testing agency showing compliance with specified ASTM requirements.
   2. Preparation instructions and recommendations.
   3. Storage and handling requirements and recommendations.
   4. Installation methods.

C. Shop Drawings:
   1. Layout drawings of each paved area showing the pattern of pavers, indicate pavers requiring cutting, indicate setting bed methods in each area, drainage patterns and drains. Include details of setting beds, noting all materials and their thickness, show details at curbs and vertical surfaces.
   2. Details of custom (nonstandard) curbs and stair tread/risers, include methods of installation.

D. Selection Samples: For each finish product specified, two complete sets of color chips representing manufacturer's full range of available colors and patterns.

E. Product Sheets Verification Samples: For each finish product specified, sample of each manufactured, type, size and color selected or specified.

F.

1.5 QUALITY ASSURANCE

A. Verify drawing dimensions with actual field conditions. Inspect related work and adjacent surfaces. Report to the Owner's Representative all conditions, which prevent proper execution of this work or that, are different from those shown.

B. Manufacturer Qualifications:
   1. Products shall be produced by a single manufacturer /quarry unless otherwise specified.
   2. Manufacturer shall submit evidence of having not less than fifteen years successful production of this product.
   3. The paver manufacturer shall demonstrate, either by proven field performance

or a laboratory freeze-thaw test, that the paving units have adequate durability if they are to be subjected to a freeze-thaw environment.

A. Satisfactory field performance is indicated when units similar in composition and made with the same manufacturing process as those to be supplied to the purchaser, do not exhibit objectionable deterioration after at least 5 years.

B. The units used as the basis for proven field performance shall have been exposed to the same general type of environment, temperature range and traffic volume as is contemplated for the units supplied to the purchaser.

C. Installer Qualifications:

1. Subcontractor shall submit evidence of skill and not less than five years specialized experience with this product.

D. Mock-Up:

1. Provide a mock-up for evaluation of surface preparation techniques and application workmanship.
2. 10 feet by 10 feet at area designated by Architect or Landscape Architect.
3. Do not proceed with remaining work until workmanship, color, and sheen are approved by Architect or Landscape Architect.
4. Refinish mock-up area as required to produce acceptable work, mock up may remain as part of work if acceptable.

D. Pre-installation Meeting:

1. Hold a pre-installation conference, prior to start of stone paving installation. Attendees shall include Contractor, Architect, installer, Owner's Representative, and manufacturer's designated representative.
2. Review all related project requirements and submittals, status of substrate work and preparation, areas of potential conflict and interface, availability of stone pavers and components, installer's qualifications, equipment, and coordinate methods, procedures and sequencing requirements for full and proper installation, integration and protection.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver and handle precast concrete pavers in such a manner as to prevent damage. Units shall be stored above ground on pallets. Pallets shall be clean and non-staining. All damaged or otherwise unsuitable material shall be immediately removed from the job site.

B. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.7 SAMPLING AND TESTING

A. Paver Sampling:

1. Full size pavers of each color shall be randomly selected from approximately equal sections of the consignment to suit testing frequency.

3. All paver samples shall be clearly marked at the time of sampling in such a way that the designated sections of the works can be identified.

B. Paver Testing:

1. All paver samples shall be laboratory tested by an independent testing company meeting the approval of the Owner's Representative prior to shipping to the site. Sampling shall be carried out at the time of packaging in the place of manufacture
2. Physical characteristics tested to ASTM C-616 shall be carried out at a rate of (1) set of tests (5 samples) per 1,000 pavers of each size and color, or part thereof.
2. Manufacturer shall provide petrographic testing on pavers, which meet UNI 9724/I and ASTM C-295.
3. Samples for compressive strength testing for dry and weight tested to ASTM C-170 shall be carried out at a rate of (1) set of tests (5 samples) per 1,000 pavers. Compressive strength shall be tested in accordance with UNI 8635/11 freezing and thawing for 25 cycles.
3. Absorption by weight and bulk specifying gravity tested to ASTM 97.
4. Module of rapture, flexure tests to ASTM 99 at a rate of one set of tests (five pavers each) per 1,000 pavers. Module of rapture, flexure test shall be tested in accordance with UNI 8635/11 freezing and thawing for 25 cycles.

C. Sand supplier's testing shall be carried out by an independent testing company meeting the approval of Owner's Representative. The following testing shall be carried out at the specified frequency.

1. Particle size distribution testing of the bedding and jointing sand shall be carried out at a rate of one per 5,000 square feet.
2. Sand degradation testing shall be carried out on the bedding sand at a rate of one test per 5,000 square feet.
3. The Owner may elect to sample the test materials delivered to the site that he considers to be no-complaint. These tests shall be borne by the Contractor.
4. Where any of the individual test results fail to meet the specified requirements, the consignment shall be rejected subject the following option. The manufacture/supplier may elect to inspect the consignment, remove any part he considers to be defective and submit the remainder for sampling by the Owner at twice the original test requirement. Should their further test fail to meet the requirements, the entire consignment shall be rejected and shall be removed from the site at the manufacturer's/supplier's expense.

D. Untreated base course, structural fill and subgrade testing shall be carried out by an independent testing company meeting the approval of Owner's Representative. <u>Proctor Tests</u>: Compaction of the natural or imported base Field in-place density tests shall be performed according to AASHTO Designation T-180, ASTM D1557, ASTM D 6938, ASTM D 1556, ASTM D 2167, or ASTM D 2937, as applicable. Testing laboratory shall submit test results directly to the Owner's Authorized Representative for review and acceptance.

1. Paver Areas: At subgrade and at each compacted fill and backfill layer, perform at

least one field in-place density test for every 5,000 sq. ft. or less of paver area and at least one test for each individual paver area, but in no case fewer than three tests as directed by the Owner's Authorized Representative

E. All costs incurred in re-sampling, retesting shall be paid by the Contractor.

F. When subgrade, fills or backfills are below specified density, scarify and moisten or aerate, or remove and replace soil to the depth required, recompact and retest until required density is obtained.

1.8 PROJECT CONDITIONS

A. Cold-Weather Protection: Do not use frozen materials or build on frozen subgrade or setting beds.

B. Weather Limitations for Mortar and Grout:
1. Cold-Weather Requirements: Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.
2. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602. Do not apply mortar when substrate temperatures exceed 100 deg F.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturer: Rhodes Architectural Stone; Contact Brian Arnold, work: 206 709-3000-101, mobile: 206-327-0833

B. Requests for substitutions will be considered in accordance with provisions of Division 1. General Requirements.

2.2 PAVERS

A. Granite Pavers: sawn 6"x6" Dune (color) Granite cut pavers with bush hammer finished surface s as manufactured by Rhodes Architectural Stone.
1. Nominal Size: 6" x 6" and 3" thick (cubes) in areas intended for light vehicular traffic, all other areas shall use 2" thick paver as indicated on drawings.
2. Color: Dune
3. Installation Patterns: Running Bond
4. Free of chips that extend more than (1/4") in from the edge

B. Performance Requirements:

1)The stone comply with the ASTM C-616
2)Shall comply with the UNI 9724/1 and ASTM C-295.

3)Modulus of Rupture:	1,900 psi	per ASTM C 99.
4)Compressive Strength:	17,622 psi	per ASTM C 170.
5)Flexural Strength:	3,141 in.lb.	per ASTM C 880.
6)Absorption:	0.647%	per ASTM C 97.
7)Density:	160 lbs/cu.ft.	per ASTM C 97.
8)Static Coefficient of Friction:	0.62 in.lb.	per ASTM C 1028.
9)Abrasion Resistance:	70.92 in.lb.	per ASTM C 241.

2.3 SETTING MATERIALS

A. Untreated (aggregate) Base Coarse: Sound, non-expansive angular crushed stone or gravel complying with ASTM Standards for base course

SIEVE SIZE	IDEAL GRADATION (PERCENT PASSING)	IDEAL GRADATION TOLERANCE (PERCENT)
1”	100	± 6
½”	85	± 6
No. 4	55	± 6
No. 16	31	± 4
No. 50	19	± 4
No. 200	9	± 2

B. Metal Edge Restraints: Permaloc Aluminum “Asphalt Edge” with Mill Finish (raw). Install 2.5 inch tall edge with 2” thick pavers and 3 inch tall edge with 3” thick pavers. Install per manufactures instructions. Contact Robert J. Kimball at Permaloc Corp. at Ph. 800.356.9660 or e-mail Rob.Kimball@Permaloc.com

C. Sand for Leveling Course: Sound, heavy coarse clean, naturally occurring silica sand with sharp sub-angular particles.washed, natural sand complying with gradation requirements in ASTM C 33 for fine aggregate. The sand shall contain no more than 10% acid soluble material. Do not use stone dust, mason, or manufactured sand for Leveling Course. Provide gradations as follows:

Sieve Size	Percent Passing
3/8 in.(9.5 mm)	100
No. 4 (4.75 mm)	95 to 100
No. 8 (2.36 mm)	85 to 100
No. 16 (1.18 mm)	50 to 85
No. 30 (0.600 mm)	25 to 60
No. 50 (0.300 mm)	10 to 30

No. 100 (0.150 mm)	2 to 10
No. 200 (0.075 mm)	0 to 1

Sand to be free of organic materials and any other contaminates that could potentially stain or otherwise damage the unit pavers. Bedding layer shall consist of a sand /cement mix, at a ratio of 12 parts sand and 1 parts type II cement. The components shall be machine mixed to ensure a uniform, well-amalgamate mixture in every part of the bedding. Lay bedding on sub-base at a maximum of 1" thick.

D. Drainage Geotextile: Nonwoven needle-punched non-biodegradable geotextile fabric, manufactured for subsurface drainage applications, made from polyolefin or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:

1. Apparent Opening Size: No. 40 sieve, maximum; ASTM D 4751.
2. Permittivity: 0.5 per second, minimum; ASTM D 4491.

E. Herbicide: Commercial chemical for weed control, registered with the EPA. Provide in granular, liquid, or wet-able powder form.

2.4 JOINT MATERIALS

A.Sanded Epoxy Joint Filler: GftK VDW 815. Contact Miles Chaffee with Milestone Imports; ph. 505-989-1999 x 1, e-mail: miles@milestoneimports.com

B.Joint Colors: Match stone color

C.Water: Potable.

D.Adhesive/Mortar: Type S mortar at edges or under site furnishings as needed.

2.5 SOURCE QUALITY CONTROL

A. Fabrication Tolerances:

1)Maximum variations in stated thickness: plus or minus 1/2 inch.
2)Sawn edge pavers width tolerance: plus or minus 1/16 inch.

PART 3 EXECUTION

3.1 EXAMINATION

A. Do not begin base course installation until substrates have been properly prepared. Compact soil subgrade uniformly to at least 95 percent per ASTM D 1557 laboratory density.

B. If substrate preparation is the responsibility of another installer, notify Landscape Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces using the methods for achieving the best result for the substrate under the

project conditions.

3.3 INSTALLATION

A. Place untreated aggregate base course, compact by tamping with plate vibrator to required density, and screed to depth indicated. Place drainage geotextile over compacted base course, overlapping ends and edges at least 12 inches. Place leveling course and screed to a thickness of 1 inch taking care that moisture content remains constant and density is loose and uniform until pavers are set and compacted.

B. Treat leveling course with herbicide to inhibit growth of grass and weeds.

C. Layout pavers per specified pattern and vibrate pavers into leveling course with a low-amplitude plate vibrator capable of a 3500- to 5000-lbf compaction force at 80 to 90 Hz.

D. Placement Tolerance:

1. Maximum of 1/16 inch (1.6 mm) height variation between adjacent pavers.
2. Individual pavers shall not vary more than 1/16 inch (1.6 mm) from level across width of the paver.
3. Paved areas shall not vary more than 1/4 inch (6 mm) from level in a distance of 10 feet (3 m) measured at any location and in any direction.
4. Set pavers with a joint width not to exceed 1/4 inch, being careful not to disturb leveling base. Use string lines to keep straight lines.

E. Sand Setting Bed Installation:

1. Place solid steel 3/4 or 1 inch (19 mm or 25 mm) thick control bars directly on the base. Install shims under bars for minor adjustment of depth and finish paver elevations and slopes. Space bars approximately 11 feet (3.4 m) apart and parallel to each other to serve as guides for strike-off boards.

2. Place sand setting bed between control bars on the binder course to not less than thickness of the designated control bars. Spread material and strike off by pulling the material with a 12 feet long by 2 inches by 6 inches (3.7 m by 51 mm by 152 mm) wood board several times to produce a smooth firm and even setting bed. Add fresh material in low areas after each pass of the strike off board. After each panel is complete remove and advance the first control bar to the next panel position in readiness for placing and striking adjacent panels. Fill in depressions left by the control bar and any shims.

F. Provide edge restraints as indicated. Install edge restraints before placing stone pavers as per manufactures installation recommendations.

G. Joint Filler: Install Per manufactures installation recommendations

3.4 ADJUST AND CLEAN

A.. Finished work should be cleaned to remove impurities on the surface. The surface shall be made clean and free from oil, lateen, dust and any loose material.

END OF SECTION

SECTION 321540 - STONE DUST SURFACING

PART 1 - GENERAL

1.1 SUMMARY

A. The work of this Section consists of but not limited to providing all equipment and materials to construct the **(Stabilized)** stone dust surfacing, including aggregate base, temporary forms or edging**. DO NOT COMPACT OR ADD STABILIZED STONE DUST IN PLANTING AREAS WHERE USED AS A DECORATIVE MULCH (see plans and plan notes)**

1.2 GENERAL PROVISIONS:

A. The Contract and General Conditions and all Sections of the Construction Documents are a part of this Section.

1.3 RELATED WORK UNDER OTHER SECTIONS:

A. The following items of related work are specified and included in other Sections of the Specifications:
   1. Division 31 - Earthwork

1. 4 REFERENCES

A. The following standards will apply to the work of this Section:
   1. American Society for Testing and Materials (ASTM):
      a. D1557 - Laboratory Compaction Characteristics of Soil Using Modified Effort Using [56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)]
      b. D4546 - One Dimensional Swell or Settlement Potential of Cohesive Soil

1.5 SUBMITTALS

A. Submit for Landscape Architect's approval a 5 pound (2.3 kg) sample of stone dust material demonstrating material gradation and color for review and acceptance.

   1. Proctor Tests: Compaction of the natural or imported base shall be tested in accordance with AASHTO Designation T-191. All testing procedures and any additional tests which may be required shall follow those specified in the most recent edition of <u>State of Utah Standard Specifications for Road and Bridge Construction</u>.
   2. Metal Edging product sheet

1.6 TESTING

A. Proctor Tests: Compaction of the natural or imported base and compacted stone dust surfacing shall be tested in accordance with AASHTO Designation T-191. All testing procedures and

any additional tests which may be required shall follow those specified in the most recent edition of State of Utah Standard Specifications for Road and Bridge Construction.

B. All costs incurred in sampling and re-sampling, testing and retesting shall be paid by the Contractor.

1.7 QUALITY ASSURANCE

A. The Owner reserves the right to test and inspect materials and construction of stone dust surfacing.

PART 2 - PRODUCTS

2.1 AGGREGATE BASE COURSE

A. Aggregate for base course shall be a dense graded crushed stone that shall consist of inert angular material derived from a stone quarry that is hard, durable stone and stone screenings, free from loam and clay, surface coatings, and plastic materials.

Sieve No.	Percent Passing by Weight
2" (50 mm)	100
1-1/2" (37.5 mm)	70-100
3/4" (19.0 mm)	50-85
#4 (4.75 mm)	30-55
#50 (300 um)	8-24
#200 (75 um)	3-10

2.2 STONE DUST

A. Stone dust will be decomposed granite, or basalt trap rock meeting the following gradation:

Sieve Size	Percent Passing by Weight
No. 4 (4.75 mm)	100
No. 8 (2.36 mm)	90-100
No. 40 (0.425 mm)	20-40
No. 100 (0.150 mm)	10-30
No. 200 (0.075 mm)	0-20

1. Stone Dust available through Grass Roots Agronomics, Inc., or approved equal.
   Contact: Robert Parrish, (208) 365-1246
   Product: #4 Crusher Fines, “Permebark” or Idaho Grey Brown Basalt

B. Stone dust will be dark gray and brown/rust in color and or overall visual appearance.

C. Color will be relatively uniform.

2.3 STONE DUST BINDER

A. Stone Dust Binder shall be Stabilizer, available via Stabilizer Solutions, 602.225.5900, or approved equal. Add stabilizer per product recommendations

2.4 METAL EDGING

A. Metal Edge Restraints: Permaloc Aluminum "Asphalt Edge" with Mill Finish (raw). Install 4 inch tall. Install per manufactures instructions. Contact Robert J. Kimball at Permaloc Corp. at Ph. 800.356.9660 or e-mail Rob.Kimball@Permaloc.

2.5 WASHED 1" BASALT NON COMPACTING AGGREGATE (above tree rootballs)

A. 1" AGGREGATE to match color of stone dust, available through Grass Roots Agronomics, Inc., or approved equal. Contact: Robert Parrish, (208) 365-1246

PART 3 - EXECUTION

3.1 GRADING:

A. **NON**-PLANTING Areas to receive stone dust surfacing will be compacted and brought to subgrade elevation under Division 31 Section, Earthwork, before work of this Section is performed. Provide final fine grading, furnishing and installing base course, and stone dust surface and compaction of these materials as required to form a firm, uniform, accurate, and unyielding stone dust surface. Surface will be constructed at required elevations and to required lines, will be done under this Section and paid for under this Section.

B. Existing subgrade material that does not readily compact as required will be removed and replaced with satisfactory materials. Additional materials needed to bring subgrade to required line and grade and to replace unsuitable material removed will be material conforming to this Section.

C. Subgrade of areas to receive stone dust surfacing will be re-compacted as required to bring top 4 inches (100 mm) of material immediately below stone dust to a compaction of at least 92 percent of maximum density, as determined by ASTM D 1557. Subgrade compaction will extend for a distance of at least 6 inches (300 mm) beyond proposed edge of stone dust surface.

D. Excavation required in subgrade will be completed before fine grading and final compaction of subgrade are performed. Where excavation must be performed in completed subgrade or base course, subsequent backfill and compaction will be performed as directed by the Landscape

Architect as specified in Division 31 Section, EARTHWORK. Completed subgrade after filling such areas will be uniformly and properly graded.

E. Areas being graded or compacted will be kept shaped and drained during construction. Ruts greater than or equal to one inch (25 mm) deep in subgrade will be graded out, reshaped as required, and re-compacted before placing stone dust surfacing.

F. Materials shall not be stored or stockpiled on subgrade.

G. Disposal of debris and other material excavated and/or stripped under this section, and material unsuitable for or in excess of requirements for completing work of this section will be disposed of off-site.

3.2 BASE COURSE

A. Base course shall be spread in layers from self spreading vehicles equipped with automated grade controlled equipment for cross sections greater than 10 feet (3.00 m) in width and by hand for cross sections less than or equal to 10 feet (3.00 m) in width. Power graders or conventional self spreading vehicles may be used only with prior written approval of the Owner's Representative. Base course shall be compacted until the surface is even and true to the required lines and grades within a tolerance of 3/8 inch (9mm) above or below the required cross sectional elevations and to a maximum irregularity not exceeding 3/8 inch (9 mm) under a 10 foot (3.00 m) line longitudinally.

B. Any specific area of base course which, after being rolled, does not form a satisfactory, solid, stable foundation shall be removed, replaced and recompacted by the Contractor at no additional cost to the Owner.

C. Compaction of base course shall be to 95 percent of maximum density as determined by ASTM D 1557 and shall be verified by compaction testing. Compaction testing shall be completed at the contractor's expense. Test results shall be provided to Landscape Architect for review and approval.

D. Width of base course shall be greater than or equal to the width of stone dust surface, if continuous lateral support is provided during rolling, and shall extend at least 2 x base thickness beyond edge of the course above, if not so supported.

E. Material shall be applied in lifts less than or equal to 3 inches (75 mm) thick, compacted measure. Each lift shall be separately compacted to specified density.

1. Rolling shall begin at sides and progress to center of crowned areas, and shall begin on low side and progress toward high side of sloped areas. Rolling shall continue until material does not creep or wave ahead of roller wheels.

F. Subgrade and base course shall be kept clean and uncontaminated. Less select materials shall not be permitted to become mixed with base course. Materials spilled outside stone dust surfacing lines shall be removed and area repaired.

G. Portions of subgrade or of construction above which become contaminated, softened, or dislodged by passing of traffic, or otherwise injured, shall be cleaned, replaced, re-compacted, or otherwise repaired to conform to the requirements of this specification before proceeding with next operation.

D. Water shall be added to stone dust surface as required to achieve dense, hard packed surface conforming to the finish grades indicated.

E. Variations in smoothness of finished stone dust surface will be less than or equal to 1/4 inch (6.4 mm) when tested with a 10-foot (3.00 m) straightedge, applied both parallel to and at right angles to centerline of stone dust surface areas. Irregularities exceeding these amounts or which retain water on surface will be corrected by removing defective work and replacing with new material conforming to this specification.

3.3 STABALIZED STONE DUST SURFACING INSTALLATION

A. Pre-mix Stabilizer with crushed aggregate at the rate of 15-lbs of Stabilizer per 1-ton of aggregate. Drop spreading of Stabilizer over pre-placed aggregate or mixing by rototilling is NOT acceptable. Stabilizer should be mechanically blended (Bucket blending is not an approved blending method). Stabilizer can be blended by cement mixer, pug mill, Dakota blender, generally any paddle type blenders (no screw type blenders). If you wish to use another type of blender, please verify with the company. Always blend the material DRY and leave material in mixer for several passes of the mixing paddles. Stabilizer will disappear within the material quickly, but may not be blended completely. After Stabilizer is blended into aggregate, confirm that Stabilizer has been thoroughly blended. The best way to do this is the 'ball test.' The result should be an aggregate ball with a doughy consistency that holds together. You should be able to toss the ball in your hand without it breaking apart.

B. Stabilized Stone dust surfacing will be placed only after excavation and construction work that might injure the surfacing have been completed. Stone dust surfacing shall be placed after adjacent concrete work or edgings have been installed. Damage to concrete walks, edging, stone dust surfacing, adjacent grades or materials occurring during construction will be repaired by the Contractor before acceptance at no additional cost to the Owner.

C. Stabilized Stone dust surfacing shall be constructed on the compacted base course as detailed.

D. Stabilized Stone dust surfacing shall be installed in two lifts of 2" each constructed on the compacted base course as detailed.

E. Spread Pre-Mixed Binder and stone dust evenly over the base course and rake smooth to the required grade and cross section as shown on the Contract Documents. Place material to sufficient depth to allow 4 inch depth after compaction. Do not install Stabilized aggregate during rainy conditions or below 40 degrees Fahrenheit and falling.

F. Water shall be added to stone dust surface to achieve saturation of entire depth of Stabilized Stone Dust aggregates. To achieve saturation of Stabilized aggregate profile, 25 to 45-gallons of water per 1-ton must be applied. During water application, test moisture penetration using a probing device reaching full depth.

G. Contractor will wait a minimum of 6 hours or until such time that the paving material is able to accept compaction from a one-ton roller without separation, plowing or any other physical compromise of the paving material. The aggregate will begin to dry out and setup. Compaction can begin when you can walk on the material without significantly sinking in and material does not feel too muddy. Do not allow material to dry out completely. If surface aggregate dries significantly quicker than subsurface material, lightly mist surface before compaction. Compact the material to 95 percent of maximum density as determined by ASTM D 1557 with a compactor as specified above. DO NOT use a vibratory plate compactor or vibration feature on roller, as vibration separates large aggregate particles. Compaction shall be verified by compaction testing. Compaction testing shall be completed at the contractor's expense. Test results shall be provided to Landscape Architect for review and approval.

H. Variations in smoothness of finished stone dust surface will be less than or equal to 1/4 inch (6.4 mm) when tested with a 10-foot (3.00 m) straightedge, applied both parallel to and at right angles to centerline of stone dust surface areas. Irregularities exceeding these amounts or which retain water on surface will be corrected by removing defective work and replacing with new material conforming to this specification.

3.4 WARRANTY

A. Contractor shall provide, for a period of 60 days, unconditional maintenance to include complete repairs to any area of the stabilized stone dust surface that fails.

END OF SECTION 321540

SECTION 321600 - CURBS AND GUTTERS

PART 1 GENERAL

1.01 WORK INCLUDED

A. Provide all equipment, materials, labor, tools, and transportation and other items required to provide and install subgrade preparation, drainage course placement, formwork, and placement and finishing of portland cement concrete curbs, gutters, walks and drive aprons.

B. Protection of newly constructed curbs, gutters, drive aprons and walks.

C. Curing provisions.

1.02 RELATED WORK

A. Section 321100 - Base Course

B. Section 031100 - Concrete Formwork

C. Section 033000 - Cast in Place Concrete

1.03 QUALITY ASSURANCE

A. Use workmen thoroughly trained and experienced in placing and finishing the type of work specified.

B. Comply with applicable federal, state, and local codes and regulation.

C. Comply with hot or cold weather requirements.

D. Concrete work shall be warranted against defects in materials or workmanship for a period of two (2) years, subject to applicable laws and regulations. In no case shall the Work be warranted for less than one (1) year.

1.04 REFERENCES

A. American Concrete Institute (ACI)

1. Manual of Concrete Practice, 1985, Part 2:
   a. ACI 305R-77- Hot Weather Concreting
   b. ACI 306R-78 - Cold Weather Concreting
   c. ACI 318 - Building Code Requirements

B. American Society for Testing and Materials (ASTM)

1. D1751 - Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction

2. C150 - Portland Cement

3. C33 - Concrete Aggregates
4. C94 - Ready Mixed Concrete

C. American Association of State Highway and Transportation Officials (AASHTO)

D. Federal Standard (FS)

1.05 SUBMITTALS

A. Submit concrete trip tickets to Owner's representative at the time of delivery to the site.

B. Submit mix design in accordance with Section 033000.

C. Submit construction, expansion, and contraction joint layout plan for approval.

D. Submit manufacturers data for all products proposed.

1.06 METHOD OF MEASUREMENT AND BASIS FOR PAYMENT

A. Furnish and Install Curb and Gutter. Measurement and payment will be based upon the in-place lineal footage of concrete receiving curb and gutter installed with 8" of compacted base course. Such payment shall include the costs of compacted road base material, fiber mesh reinforcement, and all labor, materials, tools and equipment needed to complete this work.

B. Furnish and Install 4" Thick Concrete Sidewalk. Measurement and payment will be based upon the in-place square footage of concrete slab installed with 8" of compacted base course. Such payment shall include the costs of compacted road base and concrete materials and all labor, materials, tools and equipment needed to complete this work.

1.07 DELIVERY AND HANDLING

A. Ready mixed concrete shall be delivered to the site only in such quantities as are required for immediate use. The maximum allowable time between charging of the material in the mixing drum and final placing shall be not more than ninety (90) minutes when ambient temperatures are below 80 degrees F and not more than sixty (60) minutes when ambient temperatures are above 80 degrees F.

B. Concrete which has reached initial set prior to placement, or retempered concrete is not acceptable, and shall not be used in the Work, and shall be promptly removed from the project site.

1.08 PROJECT CONDITIONS

A. Concreting operations shall not be performed when air temperature at the project site falls below 40 degrees F.

B. Concreting operations shall not be performed when air temperature at the project site rises above 105 degrees F.

PART 2 PRODUCTS

2.01 CONCRETE MATERIALS AND MIXTURE

A. Shall be in accordance with Section 033000.

B. Cement shall comply with the requirements of ASTM C150, Type II.

C. Coarse Aggregate shall comply with the requirements of ASTM C33 and Section 321123 of these specifications.

D. Fine Aggregate shall comply with the requirements of ASTM C33 and Section 033000 of these specifications.

E. Admixtures shall not be allowed in portland cement concrete with the following exceptions:

1. Air Entraining Admixture shall comply with the requirements of ASTM C260.

F. Concrete curing compound shall comply with ASTM C309, Type II, Class A and shall restrict moisture loss to 0.055 gr./sq.cm when applied at a rate of 200 sq.ft./gal.

G. Mix design shall comply with Section 033000 of these specifications.

2.02 JOINT MATERIALS

A. Filler material shall be pre-formed, non-extruding resilient type conforming to the requirements of ASTM D544 of appropriate thickness to fill joint.

B. Joint sealant shall be polyurethane based, self leveling, one part elastomeric sealant complying with the requirements of FS-TT-S00230 Class A, Type I unless Type II is recommended for the intended application by the sealant manufacturer.

C. Select joint materials of sufficient strength, hardness and durability to withstand stiletto heel traffic without damage or deterioration.

2.03 REINFORCEMENT

A. Reinforcement shall comply with the requirements of Section 031100 of these specifications.

2.04 FORMWORK

A. Formwork shall comply with the requirements of Section 031100 of these specifications.

2.05 EQUIPMENT

A. Equipment for placing concrete shall comply with the requirements of Section 033000 of these specifications.

PART 3 EXECUTION

3.01 PREPARATION

A. Remove all wood scraps, ice, snow, frost and debris from the areas in which concrete will be placed. Concrete shall not be placed on frozen ground or in standing water.

B. Thoroughly clean the areas to ensure proper placement and bonding of concrete.

C. Thoroughly wet the forms (except in freezing weather), or oil them; remove all standing water.

D. Thoroughly clean all transporting and handling equipment.

E. Notify the Owner at least 24 hours before placing concrete.

F. Obtain the Engineer's approval of location of construction, expansion, or control joints prior to the start of concrete placement.

G. Verify that reinforcement is free of loose mill scale, mud, paint, oil, grease, or other materials which may hinder proper bonding of concrete to reinforcement.

3.02 PLACING STEEL REINFORCEMENT

A. Steel reinforcement shall be placed in accordance with the requirements of Section 031000 of these specifications.

3.03 PLACING CONCRETE

A. Concrete shall be placed in accordance with the requirements of Section 033000 of these specifications.

3.04 SIDEWALK, DRIVEWAY, AND CURB AND GUTTER JOINTS

A. Locate all joints according to the approved joint plan, making all joints perpendicular and straight.

B. Joints for existing structures or paving removed or damaged as a result of the Work shall be replaced, matching joints in original structure as closely as possible.

C. Expansion Joints

1. Expansion joints in sidewalks shall be one half inch (½") in thickness and shall be placed where sidewalk joins existing walks, fixed objects, and at curbs at all handicap ramps using premolded expansion joint filler. Expansion joints shall not be spaced greater than 50' on center. Dowel bars are not required at expansion joints unless indicated on the drawings.

2. Expansion joints in curb and gutter shall be one half inch (½") in thickness and shall be placed between curb and gutter and storm drain structures, at changes in direction, or at intervals not exceeding 50' using pre-molded expansion joint filler.

3. Joint sealant shall be installed over all expansion joints. Provide and install bond breaker per the manufacturer's recommendations.

D. Contraction Joints

1. Sidewalks
   a. Contraction joints shall be installed at intervals equal to the width of sidewalk using steel plates not less than 1/8" nor more than 1/4" in thickness.
   b. Remove steel plates once concrete has reached initial set.
   c. Tooled joints shall be rounded to provide a neat, workmanlike appearance.
   d. Joints may be provided by cutting into fresh concrete to a minimum depth of 1/4 of the walk thickness. Cut joints shall be straight and perpendicular to walk.

2. Curb and Gutter
   a. Contraction joints shall be installed according to the approved joint plan using steel templates not less than 1/8" nor more than 3/16" in thickness.
   b. Remove steel templates once concrete has reached initial set.
   c. Curb and gutter placed by slipform methods shall have joints installed every 10' by cutting into fresh concrete to a depth not less than 1-1/2". Round such joints to provide a neat workmanlike appearance.

E. Inspect joints upon removal of forms to verify that concrete or mortar has not sealed across the joint. Cut neatly and remove any such concrete or mortar in the joint.

3.05 HOT WEATHER CONCRETING

A. Hot weather concreting shall be performed in accordance with Section 033000 of these specifications.

3.06 COLD WEATHER CONCRETING

A. Cold weather concreting shall be performed in accordance with Section 033000 of these specifications.

3.07 FINISHING

A. Concrete surfaces shall be finished smooth and true to grade by float. The finishing shall commence immediately after the concrete is placed and shall progress at a rate equal to the paving operation. Any delay in excess of thirty minutes in performing the preliminary finishing shall constitute cause for shutting down the mixing operations until the finishing is resumed.

B. Hand methods of strike off and consolidation will only be permitted when the width of pavement to be constructed is less than 10 feet or at rounded intersection where the use of machine finishing is impractical.

C. While the concrete is still plastic the entire slab surface shall be tested by the Contractor for trueness with an accurate 10 foot straightedge. Any depressions found shall be immediately filled with fresh concrete, struck off, reconsolidated, and finished. High spots shall be struck off and refinished.

D. In advance of curing operations the pavement shall be textured by brooming. Owner shall be notified 24 hours in advance of placing and brooming operations in order to be present to review and recommend modifications to placement and finishing.

E. Finished Surface

1. The finished surface shall be true to grade and cross section, free from ruts, humps, depressions or other irregularities. The surface shall not deviate from line and grade by more than 1/8" in 10'. The determination of compliance with smoothness may be made with a straightedge or string line at the option of the Engineer. Any irregularities found shall be corrected by the Contractor using suitable grinding or grooving tools and equipment.

2. The grinding tool shall consist of a machine equipped with cutting wheels mounted on a horizontal shaft. The grinding action shall be conducted parallel to the centerline.Grinding operations may be deferred, as directed by the Engineer, whenever tearing of aggregate with the surface occurs and shall not be resumed until the concrete has hardened sufficiently to avoid tearing.

3. The finished surface across contact joints shall not deviate from a straight line by more than 1/8" in 12" when tested with a straightedge. The Contractor shall take the necessary precautions to prevent slumping of the edge of the concrete at contact joints.

4. Line and Grade Control:
   a. Contractor shall establish references at suitable intervals for line and grade control of the placing operations.
   1. Contractor shall furnish, place and maintain such supports, wire devices and materials that may be required to provide continuous line and grade reference controls to the placing machine, trimmers, or paver.

3.07 CURING

A. Protect placed concrete from the effects of hot or cold weather as required under Section 033000 of these specifications.

B. Membrane Curing Compound

1. Surfaces of newly placed or exposed concrete shall be kept moist or wet until the curing compound is applied. The curing compound shall be applied immediately after all patching or surface finishing has been completed.
2. The curing compound shall be delivered to the work in ready mixed form. At the time of use, the compound shall be in a thoroughly mixed condition with the pigment uniformly dispersed throughout the vehicle. The compound shall not be diluted or altered in any manner.

3. Curing compound that has become chilled to such an extent that it is too viscous for satisfactory application shall be warmed to a temperature not exceeding 100 degrees F, unless otherwise specified by the manufacturer's recommendations.
4. The curing compound shall be applied to the exposed surface at a uniform rate of 1 gallon per 100 square feet, unless otherwise specified by the manufacturer's recommendations.
5. In the event that the application of curing compound is delayed, the application of water spray, ponding, or soaked tarps shall be started immediately and shall be continued until application of the compound is started or resumed.

3.08 PROTECTION

A. Contractor shall protect the concrete against all damage and markings.

B. Erect and maintain suitable barricades and barriers to protect the finished surface. Any sections damaged from traffic or other causes prior to final acceptance shall be removed, replaced, or repaired to the Owner's satisfaction at no additional expense to the Owner.

C. Concrete surface shall be protected against pitting or damage due to rain.

END OF SECTION 321600

SECTION 323100 - SITE IMPROVEMENTS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. The General Documents, as listed on the Table of Contents, and applicable parts of Division 1, General Requirements, will be included in and made a part of this Section.

B. Examine all Contract Documents and all other Sections of the Specifications for requirements therein affecting the work of this trade.

1.2 SUMMARY

A. The work of this Section consists of providing all labor, equipment, materials, incidental work, and construction methods necessary to furnish and install designated Site Improvements and related items as indicated on the Contract Documents, as specified in this Section, and includes, but is not limited to, the following:

1. Benches
2. Trash Receptacles
3. Bike Racks
4. Drain Grates

1.3 RELATED WORK UNDER OTHER SECTIONS

A. Related work specified and included in other Sections of the Specifications:

1. Division 31 - Earthwork
2. Section 321312 – Site Concrete

1.4 REFERENCES

A. The following standards will apply to the work of this Section:

1. American Society for Testing and Materials (ASTM).
   a. ASTM A-53/A53M-01 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   b. ASTM D143-94(2000)e1 Standard Methods of Testing Small Clear Specimens of Timber.
   c. ASTM D 198-99 Standard Test Methods of Static Tests of Lumber in Structural Sizes.
   d. ASTM E 228-95 Standard Test Method for Linear Thermal Expansion of Solid Materials With a Vitreous Silica Dilatometer.
2. TT-C-490C, Methods I and III.
3. AWS standard D1.1.

1.5 SUBMITTALS

A. Furnish for approval all Manufacturers' product data and specifications for all items listed in this Section

B. Shop Drawings: The contractor shall submit Shop Drawings where noted for review and acceptance prior to product fabrication or delivery to the site. Shop Drawings shall be complete with respect to quantities, dimensions, specified performance and design criteria, materials, color, and similar data to enable an adequate review of the information required.

1.6 SUBSTITUTIONS

A. Any proposed product substitutions shall be in accordance with the General Conditions; shall meet or exceed specified warranty; shall be equivalent in specific features and qualities such as performance, weight, size, durability, visual effect; shall be compatible with the rest of the work; and shall not require any changes or revisions to the Construction Documents.

1.7 QUALITY ASSURANCE AND STANDARDS

A. Workmanship and finish will be equal to the best practice of modern shops for each item of work.

A. Inspect all components for correct fabrication and compliance with Specifications.

1.8 DELIVERIES, STORAGE, AND HANDLING

A. Store delivered Site Improvement items under this Section in a manner to prevent wracking or stress of components, and to prevent mechanical damage or damage by the elements.

B. Protect all stored materials and items from weather, careless handling and vandalism.

C. Items, which become rusted or damaged because of non-compliance with these conditions, will be rejected and will be replaced without additional cost to the Owner.

1.9 GENERAL INSTALLATION

A. Configure or secure exposed anchors, bolts or fasteners in such a way as to prevent their casual removal by use of vandal-proof heads or fastenings unless otherwise specified on Drawings.

B. Provision, delivery and installation of all materials, except as otherwise specified under other Sections of this Specification, will be in accordance with and paid for under the work of this Division 32 Section, Site Improvements.

C. Unless specifically called out in the Contract Documents, galvanized steel or cast iron sections to be joined will not be welded after galvanizing but will be mechanically attached by means of unexposed sleeves and fasteners sufficient to provide secure attachment under normal usage.

D. Set freestanding site improvement items plumb vertically and horizontally, regardless of the pitch of the finished surrounding grade unless otherwise shown on the Contract Documents.

E. The Contractor will be responsible for timing the delivery of site improvement items to minimize the on-site storage time prior to installation.

F. Protect all stored materials from weather, careless handling, and vandalism.

G. Contractor will be responsible for the correct location of site improvement items. Take particular care to maintain shapes, plumb and level during the pouring of concrete.

H. All Work will be accurately set to established lines and elevations and rigidly set in place to supporting construction.

1.10 COORDINATION

A. The Work of this Division 32 Section, Site Improvements, will be completely coordinated with the work of other Sections. Verify dimensions and work of other trades that adjoin materials of this Section before installing items specified.

1.11 GUARANTEE

A. The Contractor will furnish and deliver standard written manufacturer's guarantee in Owner's name covering all materials and workmanship under this Division 32 Section, Site Improvements, in addition to, and not in lieu of, guarantee requirements set forth under Division 1, General Requirements, and other liabilities which the Contractor may have by law or other provisions of the Contract Documents.

B. Pay for repairs of any damage to any part of the project, or caused by defects in his work and for any repair to the materials or equipment caused by replacement. Complete all repairs to the satisfaction of the Owner's Representative.

C. Replace any part of the work installed under this contract requiring excessive maintenance. Work of this nature will be considered defective. Replace at no cost to the Owner upon notification during the one-year guarantee period.

PART 2 PRODUCTS

2.1 BENCHES

A. Benches as specified in products and materials schedule, or equal.

2.2 TRASH RECEPTACLE

A. Trash Receptacles as specified in products and materials schedule, or equal.

2.3 BIKE RACKS

A. Bike Racks as specified in products and materials schedule, or equal.

A. EARTHWORK MATERIALS

A. All backfill materials, including base and sub base materials, ordinary borrow, drainage fill and structural fill will be as specified under the Division 31 Section, Earthwork, of this Specification, and provided, delivered and paid for under the work of this Division 32 Section, Site Improvements.

PART 3 EXECUTION

3.1 EARTHWORK

A. All excavation, filling, compacting and grading of backfill materials, including base and sub base materials, ordinary borrow, drainage fill and structural associated with and used in the installation of the items of this Division 32 Section, Site Improvements, will be as specified under the Division 31 Section, Earthwork, and performed and paid for under the work of this Division 32 Section, Site Improvements.

3.2 CONCRETE

A. Concrete footing placement, protection and formwork will be as specified under the Division 32 Section 321312 Site Concrete, of this Specification and installed and paid for under the work of this Division 32 Section, Site Improvements. Concrete footings will be to the sizes noted on the Contract Documents.

3.3 TRASH RECEPTACLE

A. Install Trash Receptacles as detailed and according to manufacturer instructions.

3.4 BIKE RACKS

A. Install Bike Racks as detailed and according to manufacturer instructions.

END OF SECTION 323100

SECTION 328400 - IRRIGATION SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes piping, valves, sprinklers, specialties, controls, and wiring for automatic-control irrigation system.

1.3 WORK TO BE DONE

A. Work to be done includes furnishing all labor, materials, equipment and services required to complete all irrigation work indicated on the Drawings, as specified herein, or both. The work to be performed under this Section shall consist of furnishing all labor and materials necessary to construct a complete working and tested sprinkler irrigation system as per all drawings and specifications, providing 100 percent head to head coverage on all lawns and planting areas on the site. Included also will be maintenance and warranties.

B. The Contractor shall perform, but not be limited to, all of the following functions: Paying all connection fees, deposits and all other charges related to the connection to the water source. Obtain all permits, complete all excavation, backfill, provide backflow device, tapping saddle, yoke, stop and waste, concrete vaults and miscellaneous pipe fitting. Make necessary road repairs, provide safety barrier, and make connection to water source. All in compliance to applicable codes and requirements of the utility companies involved.

C. The electrical point of connection for the irrigation system shall be 120-volt line that shall be run behind the dumpster wall.

D. The Drawings and Specifications must be interpreted and are intended to complement each other. The Contractor shall furnish and install all parts, which may be required by the Drawings and omitted by the Specifications, or vice versa, just as though required by both. Should there appear to be discrepancies or question of intent, the Contractor shall refer the matter to the Owner's Authorized Representative for decision, and his interpretation shall be final, conclusive and binding.

E. All necessary changes to the Drawings to avoid any obstacles shall be made by the Contractor with the approval of the Owner's Authorized Representative.

F. Trench excavation, back filling and bedding materials, together with the testing of the completed installation shall be included in this work.

G. The work shall be constructed and finished in every respect in a good, workmanlike and substantial manner, to the full intent and meaning of the Drawings and Specifications. All parts necessary for the proper and complete execution of the work, whether the same may have been specifically mentioned or not, or indicated on the Drawings, shall be done or furnished in a manner corresponding with the rest of the work as if the same were specifically herein described.

H. Record Drawing as well as Operating & Maintenance Manual generation, in accordance to these specifications shall also be included in this work.

I. If electrical service is not already in place, the Contractor will be required to make all necessary arrangements with Power Company including, but not limited to, paying fees, making power connections, providing poles, weatherhead and meter, etc., as specified on the plans. All permits, fees, and compliance with electrical company requirements, shall be the Contractor's responsibility.

1.4 SCOPE

A. The irrigation system shown on the Drawings and described within these Specifications represents an automatic controller irrigation system supplied from a secondary and culinary water system. The system is designed for a minimum operating pressure at the main connection of 100 PSI. The irrigation Contractor shall verify water pressure prior to construction and report any differences to Owner's Authorized Representative.

1.5 EXISTING UTILITIES

A. Before any trenching, excavation, or digging below the surface for any reason is begun, the Contractor shall contact the owner, Blue Stakes, and all other necessary entities in order to determine as close as possible the location of all underground utilities and structures. Although identified, underground utilities and structures will be assumed to be in approximate locations. The Contractor will conduct the work in such a manner to protect all utilities and structures from damage. It is the responsibility of the Contractor to repair or replace any damage incurred by the Contractor or the Contractor's employees with identical materials to match the existing, at no expense to the Owner.

1.6 PROTECTION OF EXISTING SITE IMPROVEMENTS

A. The Contractor shall take necessary precautions to protect site improvements to remain, including, but not limited to buildings, grounds, or utilities. Should damage be incurred by the Contractor or the Contractor's employees, the Contractor shall repair the damage to its original condition at the Contractor's own expense.

1.7 ORDINANCES, PERMITS AND FEES

A. The Work under this Section shall comply with all ordinances and regulations of authorities having jurisdiction.

B. The Contractor shall obtain and pay for any and all permits, tests and certifications required for the execution of Work under this Section.

C. Furnish copies of Permits, Certifications and Approval Notices to the Owner's Authorized Representative prior to requesting payment.

D. The Contractor shall initiate a "Request for Shutdown" any time a utility must be shut off to allow work progress. See the General Conditions for "Request for Shutdown" requirements.

1.8 EXAMINATION OF CONDITIONS

A. The Contractor shall fully inform himself of existing conditions on the site before submitting his bid, and shall be fully responsible for carrying out all work required to fully and properly execute the work of the Contract, regardless of the conditions encountered in the actual Work. No claim for extra compensation or extension of time will be allowed on account of actual conditions inconsistent with those assumed, except those conditions described in the General Conditions.

B. Verify available water supply pressure and flow characteristics.

1.9 QUALITY ASSURANCE

A. Installer: A firm that has at least five (5) years experience in work of the type and size required by this Section and which is acceptable to the Owner's Authorized Representative. The firm must have at least one direct employee with current Certified Irrigation Contractor (CIC) certification from the Irrigation Association. A registered CIC is to be included in the Contractor's work crew..

B. References: The Contractor must supply three references for work of this type and size with their bid including names and phone numbers of contact person(s).

C. Applicable requirements of accepted Standards and Codes shall apply to the Work of this Section and shall be so labeled or listed:

1. American Society for Testing & Materials (ASTM)
2. National Plumbing Code (NPC)
3. National Electric Code (NEC)
4. National Sanitary Foundation (NSF)
5. American Society of Agricultural Engineers (ASAE)
6. Underwriters Laboratories, Inc. (UL)
7. Occupational Safety and Health Regulations (OSHA)

1.10 TESTS AND INSPECTIONS

A. Observation: The Owner's Authorized Representative will be on site at various times to insure the system is being installed according to the Specifications and Drawings.

B. Pipe Testing and Inspection: The irrigation piping shall be inspected for compliance with the specifications and drawings and tested in the presence of the University's Project Manager prior to backfilling of the trenches. The Contractor shall provide the Owner's Authorized Representative 48 hours advance notice prior to the irrigation pipe testing.

C. Operational Test: After completion of the system, test the operation of entire system in the presence of the Owner's Authorized Representative to insure complete head to head coverage of all areas watered. This test must be performed by using the automatic irrigation controller. Any deficiencies identified at this time will require revisions and adjusting by the Contractor at the Contractor's expense. Any deficient irrigation head will be adjusted for proper coverage and set to proper depth at this time.

1.11 SUBMITTALS

A. List of Materials: Submit for approval a PDF of the complete list of materials proposed for use. Quantities of materials and equipment need not be included. No deviations from the specification shall be allowed, except as provided for in these documents.

B. Product Data: Submit manufacturer's technical product data and installation instructions for all irrigation system materials and products to be installed to the Owner's Authorized Representative for approval prior to the start of work, in accordance with the parameters of Division-1. Work on the irrigation system may not commence until product data submittal is received and approved. Submittals shall be marked up to show proper sizes, flows, etc.

C. Record Irrigation Drawings: The Contractor shall maintain complete Record Drawings showing all deviations from the contract documents made during construction affecting the sleeves, main line pipe, controller locations, isolation valves, remote control valves, quick coupler locations, and other equipment indicated on the drawings. All wire routing, wire size, and splices shall be

indicated. These Record Drawings shall be kept on a clean set of prints of the contract documents and will be reviewed by the Owner's Authorized Representative throughout construction to verify that changes are being recorded. Main line pipe and wire route shall have two (2) distinctly different graphic symbols (line types). These record drawings shall be submitted to the Owner's Authorized Representative before the time of the Systems Inspection/Substantial Completion Inspection. The Substantial Completion Certificate Date will not be issued until the Owner's Authorized Representative receives the Record Irrigation Drawings.

D. Maintenance Data and Operating Instructions: Submit a minimum of three (3) three ring, hard cover binders titled MAINTENANCE AND OPERATING INSRUCTIONS FOR THE SUU BEVERLY TAYLOR SORENSON CENTER FOR THE ARTS to the Owner's Authorized Representatives office prior to application for acceptance and final payment. After review and approval, the copies will be forwarded to the Owner. Included in the Maintenance and Operating Manual shall be:

1. Table of Contents
2. Written description of Irrigation System.
3. System drawings:

    a. One (1) copy of the original irrigation plan.
    b. One (1) copy of the Record Drawing.
    c. One (1) copy of the controller valve system-wiring diagram.

4. Listing of Manufacturers.
5. Manufacturers' data where multiple model, type and size listings are included, clearly and conspicuously indicating those that are pertinent to this installation.

    a. "APPROVED" submittals of all irrigation equipment.
    b. Operation.
    c. Maintenance: including complete troubleshooting charts.
    d. Parts list.
    e. Names, addresses and telephone numbers of recommended repair and service companies. A copy of the suggested "System Operating Schedule" which shall call out the controller program required (zone run time in minutes per day and days per week) in order to provide the desired amount of water to each area under "no-rain" conditions.

6. One (1) color-coded laminated zone sheets per controller showing zones as built and the areas that they water.
7. Winterization and spring start-up procedures.
8. Guarantee data.

1.12 DELIVERY, STORAGE AND HANDLING

A. Store and handle all materials in compliance with manufacturer instructions and recommendations. Protect from all possible damage. Minimize on-site storage.

1.13 GUARANTEE

A. The Contractor shall obtain in the Owner's name the standard written manufacturer's guarantee of all materials furnished under this Section where such guarantees are offered in the manufacturer's published product data. All these guarantees shall be in addition to, and not in lieu of, other liabilities that the Contractor may have by law.

B. In addition to the manufacturer's guarantees the Contractor shall guarantee the entire irrigation system, both parts and labor for a period of one (1) year from the date of Substantial Completion.

C. As part of the one-year guarantee the Contractor shall perform the first year-end winterization and spring start-up for the irrigation system. Winterization shall be coordinated with the Owner's maintenance personnel and shall be completed no later than October 15th.

D. The Contractor shall correct any deficiencies when notified during the guarantee period, and additionally correct, to the satisfaction of the Owner, any damage to buildings or grounds caused by deficient work at no cost to the Owner.

E. All guarantees shall be in writing and submitted to the Owner's Authorized Representative for review and approval on or before the date of Substantial Completion.

1.14 COORDINATION

A. The Contractor shall at all times coordinate his work closely with the Owner's Authorized Representative to avoid misunderstandings and to efficiently bring the project to completion. The Owner's Authorized Representative shall be notified as to the start of work, progression and completion, as well as any changes to the drawings before the change is made. The Contractor shall also coordinate his work with that of all other associated fields.

B. The Contractor shall be held responsible for and shall pay for all damage to other work caused by his work, workmen or sub-Contractors. Repairing of such damage shall be done by the Contractor who installed the work, as directed by the Owner's Authorized Representative.

1.15 PROCEDURE

A. Notify all city departments and/or public utility Owners concerned, of the time and location of any work that may affect them. Cooperate and coordinate with them in the protection and/or repairs of any utilities.

B. Provide temporary support, adequate protection and maintenance of all structures, drains, sewers, and other obstructions encountered. Where grade or alignment is obstructed, the obstruction shall be permanently supported, relocated, removed or reconstructed as directed by the Owner's Authorized Representative.

C. SYSTEM PRESSURE The sprinkler irrigation system is designed for 100 pounds per square inch static pressure unless otherwise specified and is schematic only, with the intent to convey full head to head coverage of the lawn and planting areas affected. The system must also provide the manufacturer's recommended minimum operating pressure or greater to every head while maintaining sufficient pressure to overcome the losses due to friction in the piping, fittings, and all other equipment.

1.16 SUBSTANTIAL COMPLETION

A. The date of Substantial Completion for the irrigation system will be when the Maintenance and Operating Manual has been approved, the As-Built Record Drawings have been submitted, and the irrigation system is working as intended as demonstrated during final inspection. This will be determined by observation by the Landscape Architect and Owner's Authorized Representative.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials to be incorporated in this system shall be new and without flaws or defects and of quality and performance as specified and meeting the requirements of the system. All material overages at the completion of the installation are the property of the Contractor and shall be removed from the site.

B. No material substitutions from the irrigation products described in these specifications and shown on the drawings shall be made without prior approval and acceptance from the Owner's Authorized Representative. If there is an existing sprinkler irrigation system on the site, the Contractor shall remove any lines being abandoned, and cap or plug the ends of lines remaining in service with proper fittings and thrust blocks. The Contractor shall remove or relocate existing heads and/or connect new lines to existing lines, as indicated on the plans.

C. Any existing head, valve, valve marker, valve box, or other existing equipment located where there will be a grade or surface material change, shall be adjusted up or down to its proper position in relation to the new finished grade, at no additional cost to the Owner, unless the plans show it to be relocated.

2.2 IRRIGATION PIPE

A. All pipe 4" and larger shall be PVC Class 200 gasketed O-ring pipe conforming to ASTM D1785-83 and ASTM D-1684 with ratings printed on pipe.

B. All pipe, main and laterals 3" and smaller, (except Flex Swing Pipe) shall be Schedule 40 pressure rated PVC with ratings printed on pipe. No pipe shall be less than 3/4" inside diameter. Do not use galvanized fittings of any kind on any PVC lines or fittings.

C. Flex swing pipe shall be THICK-WALLED POLY PIPE. This pipe is to be used only between spray heads and lateral lines and shall not exceed a distance of 2 ft. for sprays and rotors and shall only be used on heads of 7 GPM or less.

2.3 PVC IRRIGATION FITTINGS

A. Main Line Piping 4" and larger - Ductile iron gasketed fittings. All gasketed pipe fittings (elbows and tees) must be thrust blocked against undisturbed soil.

B. Main Line Piping 3" and smaller - Schedule 40 pressure rated PVC, plastic socket fittings ASTM D 2464 & 2467.
   1. Schedule 40 socket fittings shall be solvent welded joints.

C. Valve Assemblies – Schedule 40 pressure rated PVC socket fittings as manufactured by Spears, Dura, Lasco or equal. PVC threaded connections shall be made using SCH 80 toe nipples and Schedule 40 Couplers. Schedule 40 male threads will not be approved for installation.

D. Lateral Line Piping - Schedule 40 pressure rated PVC as manufactured by Spears, Dura, Lasco or equal. The first two fittings (tee or elbow) on the lateral side of the valve shall be Schedule 80 pressure rated PVC.

E. Flex Swing Piping – Schedule 80 "barbed insert elbows" by threaded 1/2" or 3/4", as manufactured by Toro, Hunter, or Rainbird.

F. Mainlines shall be connected by solvent welded joints. Use specified primer and cement.

G. Lateral lines shall be connected by either solvent welded or threaded connections. Use specified primer and cement for solvent welded connections and Teflon tape for threaded connections.

H. All nipples to be schedule 80 PVC.

2.4 SOLVENT CEMENTS AND PRIMERS

A. Solvents cements for joining PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

2.5 SLEEVES

A. Sleeves shall be installed for all irrigation pipe and wire under non-soil areas and where indicated on the Drawings. Minimum sleeve size shall be 4 inch except where noted. Schedule 40 PVC pipe shall be used except where noted. The Contractor shall mark the location of all sleeves on the Record Drawings. Control wires shall be installed in a separate 2" sleeve.

2.6 WIRE CONDUIT

A. Conduit for wiring to controllers or sensors shall be SCH-80 PVC, size as indicated chart.

Number of Wires	Minimum Conduit Size
1-7	1"
8-11	1 1/2"
12-22	2"
23-31	2 1/2"
32-36	3"

2.7 ELECTRONIC CONTROL VALVES AND CONTROL VALVE ASSEMBLIES

A. All electric remote control valves shall be of the size and type as specified on the drawings. Do not mix lawn and shrub zones. Approved electric remote control valves are:

B. All electric remote control valves shall be of the size as specified on the drawings. Do not mix lawn and shrub zones.

C. Provide valves as indicated on Drawings.

D. Do not mix lawn and shrub zones.

2.8 VALVE BOXES

A. Description

1. Valve box for electric control valves, isolation valve, and quick coupling valves shall be a rectangular valve box and bolt down cover. All valve boxes shall be color **Grey**. All electric control valves shall be installed in a Jumbo Valve Box or larger as required to fit all required components.

2. Valve boxes for drip flush valves shall be 10" round valve box.

3. Valve boxes for approved wire splices shall be 10" round valve box as manufactured by Valve boxes in all other areas may be green.

4. Valve box extensions shall be provided as required for proper box depth.

2.9 IRRIGATION CENTRAL CONTROL SYSTEM

A. BASIS OF DESIGN: Subject to compliance with requirements, provide Irrigation Central Control System and components as indicated on the drawings or other approved equal product, in compliance of substitution requirements, from other reputable irrigation manufactures that meet the following criteria. Basis of Design Central Control System and Components are available via Sprinkler Supply (Contact Joe Jackson - 801.404.1371)

B. CENTRAL COMPUTER HARDWARE: The Central Control System shall not require a dedicated computer.

C. The Central Control System shall be accessible from any web-enabled PC, laptop running at least Internet Explorer version 8, or web-enabled tablet based system.

D. CENTRAL COMPUTER SOFTWARE

1. The Central Control System shall allow for the uploading and downloading of all programs and log data by controller or groups of controllers.
2. All programming shall be capable from any Internet enabled PC, Laptop or tablet device with proper login credentials, as well as at each individual field controller.
3. The Central Control System shall allow direct, real-time access to run stations, run programs, check for flows, check master valve operation, and turn controller controlled irrigation on or off.
4. Real-time evapotranspiration must be provided, on a daily basis, to each controller, accurate to 1 square kilometer for each controller. This data must be automatically provided using a weather service that uses the internet to gather ET and rain data from multiple weather sources and uses the most appropriate data for a specific controller based upon its latitude and longitude, and calculates ET using ASCE Penman-Monteith equation. The data collected includes the, relative humidity, temperature, wind speed, and solar radiation. Information is provided by the National Oceanic and Atmospheric

Administration's (NOAA) Earth System Research Laboratory (ESRL) Global Systems Division (GSD).

5. Provider of ET must have a track record of 5 years or more.
6. Failure of the central computer system or communication links to the field controller must not affect normal, water management and/or flow management operation of irrigation controllers.

E. AUTOMATIC CONTROLLERS: All controllers shall have the following specifications and capabilities:

1. Controllers shall be capable of fully automatic, semi-automatic, and manual operation using a keypad that is an integrated part of the controller. Each controller shall be capable of storing irrigation schedules, monitor and manage flow all without the Central System (i.e. if the Central System is turned off, removed, or if communication from/to the Central Computer fails, the field controllers will continue to perform weather and flow management functions).

    a. The controller shall be able to run at least 7 valves simultaneously (programs, manual, master valve, pump start) by using at least a 3.0 amp 24VAC transformer. Each terminal output can draw up to 1 amp before being considered “over current”. The controller must support a System Over Current feature which automatically delays one stations irrigation if the activated stations are drawing too much current.

2. Backlit display shall have a minimum of three (3) lines by twenty four (24) characters so that scrolling through menus is minimized. The display shall allow the user to easily move from screen to screen through an intuitive, self-prompting display so that it is easier for the user to program, read and understand the controller. The System shall display an area description for each station including the station’s location, the type of plant material irrigated and type of irrigation equipment used.

3. The controller shall have the built-in capacity for sensing flow via two flow meter inputs and utilizing two master valves, without the addition of sensor boards, decoders, or other pieces of equipment.

4. There shall be a minimum of four (4) regular irrigation start / stop programs. Individual station cycle and soak times should be automatically calculated for each hydrozone by the controller scheduling engine. Second start times for each program must be available to support l syringe/propagation events.

5. Shall be EPA WaterSense Approved

6. The controller shall be able to receive real-time weather data directly from an ET service, and as a stand-alone controller automatically use the data to calculate appropriate run times for each station without use of a central control system.

7. The controller shall have flow management capability as a standard feature whereas the controller shall learn each station's expected GPM flow rate, and operate up to four (4) valves at the same time plus the master valve to shorten the water window.

8. When an alert, such as High Flow is indicated on the controller, the station with the High Flow shall still have an option to come on and then shut off, rather than having the alert keep the station off until someone clears the alert from the central computer or at the field controller.

9. The controller shall allow for operator-set water window, which prevents irrigation from continuing beyond a set end time. Remaining run-times shall be carried in a hold-over table and shall be applied at the next scheduled irrigation with the system prioritizing which valve to operate based on accumulated ET and the hold-over time.

10. The field controller shall come with a five (5) year warranty from the manufacturer.

2.10 CONTROL WIRE

A. Control Wire: All valve control and common wire shall be a single strand direct burial cable PE insulated type not smaller than #14 solid copper meeting all state and local codes for this service. Individual wires must be used for each zone valve. Common wire to the valves and ground wire shall be white in color. Control wires for turf areas shall be red in color. Control wires for shrub beds shall be blue. Spare wires shall be white. Control wires for Hydrometer shall be Orange

B. All wires shall be direct runs with no splices. Wires can not be spliced without approval of Owner's representative or Project Manager.

C. Splices in electric control wires shall be soldered first and then fitted with a 3M DBR/Y-6 Direct Bury Splice Kit. No exceptions**.** All splices shall be contained in a valve box with extra length equal to 12" above the top of the valve box...

D. For all areas where new wiring is required to connect hydrometers to irrigation controllers, add **one extra** control wire along with other required wiring from hydrometer back to the controller and mark in the control box as an extra wire.

E. Wire shall be pulled into controller with 12" minimum tail, and labeled to each valve. Any wire that comes from the ground to the controller must be housed in PVC conduit or flex conduit.

2.11 COMMUNICIATION CABLE

A. For direct wiring from hydrometers to new controllers. Communication cable shall be connected to hydrometers according to manufacturer's recommendations. Communication cable shall be run from the hydrometers at the noted points of connection and run to noted controllers.

B. All communication cable shall be direct runs with no splices.

C. All connections or splices in communication cable shall be made with a 3M SLiC Connector.

2.12 HYDROMETERS (MASTER VALVE/FLOW SENSOR)

A. Basis of Design: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   1. Netafim
   2. Bermad
   3. ARAD

MANUAL DRAINS

A. Provide Manual Drain as specified on the drawings in locations shown on the drawings.

2.13 ISOLATION VALVES

A. Resilient Wedge Mainline Isolation Gate Valves: shall conform to AWWA specification C 509. They shall be of Class 200 cast iron body. Resilient-seated Gate Valve and shall have a non-rising stem with rubber "0" rings and square operating nut. Stems shall be of cold rolled, solid bronze, high tensile strength. Valve shall be high strength cast iron, fully encapsulated urethane rubber wedge. Gate valves shall be hydrostatically pressure tested for 400 P.S.I. and shall be designated for a working pressure of 200 P.S.I. shall be American made – Waterous, Matco-Norca, Milwaukee or equal.

B. Ball Valves at automatic control valve(s): shall be solid bronze meeting Federal Specification WW-V-54, Class A, Type 1. Size shall be the same size as the main line on which it is installed. Valve shall be installed on the up-stream side of the electric remote control valve as detailed.

2.14 CRUSHED STONE

A. Crushed stone shall be 3/4" x #8 washed gravel. Crushed stone shall be used under valve boxes.

2.15 IRRIGATION HEADS

A. Pop-up spray and rotor heads to match existing irrigation to remain in all irrigation repair areas. Coordinate with the USU Facilities department.

B. Pop-up spray and rotor heads as specified on the drawings for all new irrigation areas.

2.16 QUICK COUPLER

A. Provide quick coupler valve as specified on the drawings in locations shown on the drawings.

2.17 MANUAL DRAIN VALVES

A. All drain valves shall be 3/4" Mueller Oriseal valve with an internal stop and installed as per details on the drawings. Drain valves are to be installed on mainlines only.

PART 3 - EXECUTION

3.1 GENERAL

A. Examine all contract documents applying to this Section noting any discrepancies and bringing the same to the attention of the Owner's Authorized Representative for timely resolution.

B. The Contractor, prior to installing the system, must verify existing water pressure. If there is a failure to obtain the needed pressure or if an excess of pressure exists for normal operation, the Contractor shall contact the Owner's Authorized Representative for any adjustments to the system. Failure to report any discrepancies in pressure due to whatever reason, and installation done prior to notification of the Owner's Authorized Representative shall be done at the expense of the Contractor.

C. Make all field measurements necessary for the work noting the relationship of the irrigation work to the other trades. Coordinate with other trades (landscaping and other site work trades). Project shall be laid out as accurately as possible as indicated on the Irrigation Plans. The drawings, though carefully drawn, are generally diagrammatic to the extent that swing joints, offsets and all fittings are not shown.

D. Irrigation heads, valves and quick coupler locations are shown on the drawings diagrammatically. It shall be the Contractor's responsibility to determine the exact location of each irrigation head, valve and quick coupler to accommodate the conditions as found on the site in order to provide COMPLETE head to head coverage of all areas. Avoid installing valves in areas where curbs and sidewalks come together or at any intersection of two or more walkways. Do NOT exceed the manufacturer's recommended spacing or as shown on the

drawings for the irrigation heads. Minor adjustments in the system will be permitted to clear existing fixed obstructions subject to the approval of the Owner's Authorized Representative. All deviations from the drawings will be noted on the "As-Built" drawings.

E. At all times, protect existing irrigation, landscaping, paving, structures, walls, footings, etc. from damage. Any inadvertent damage to the work of another trade shall be reported at once.

F. The points of reference shall be the existing walks, buildings, and curbs. The staking shall be approved by the Owner's Authorized Representative prior to commencing installation operations. Any changes in the system which appear necessary, due to field conditions, must be called to the attention of the Owner's Authorized Representative and approved at the time.

G. Install all irrigation systems as per State and Local codes.

3.2 TRENCHES AND EXCAVATION

A. Excavation work shall be as deep and as wide as will be required to safely perform the work, such as making mainline connections or forming vaults. Trenches shall be deep and wide enough to provide working space and to provide 18 to 30 inches of cover shall be placed over the top of all pipe and fittings on main lines (lines which maintain a constant water pressure). If the existing main line is deeper than 30 inches, the Contractor shall install a riser to a depth of 18 to 30 inches and then install the new line at the required 18-30" depth. At no time will the mainline be installed deeper than 30" unless prior approval by Owner's Authorized Representative. Each pipe lying in a mainline or lateral line trench shall not touch any other pipe. Maintain a pipe separation distance of 6" between each pipe.

B. There shall be a six inch (6") minimum distance between irrigation trenches and a twelve inch (12") minimum distance between any irrigation trench and trenches of other trades

C. Trenches for lines supplying pop-up spray heads shall be deep enough to maintain a minimum of 12 to 16 inches of cover over the top of all pipe and fittings.

D. Trenches for lines supplying rotors shall be deep enough to maintain a minimum of 12 to 16 inches of cover over the top of all pipe and fittings. Trenches shall also be deep enough to guarantee that all swing joints drain back to the lateral and supply lines.

E. The Contractor, in placing the irrigation lines, etc. may uncover material not suitable for finished grading. This material shall be removed from the site. After the installation of the lines, the finished grading shall be smoothed over and restored to its original condition, using additional topsoil where necessary.

3.3 PIPE AND FITTINGS INSTALLATION

A. The plans show the general arrangement of all piping. Should local conditions necessitate the rearrangement of some, or if piping can be run to better advantage, the Contractor, before proceeding with the work, shall prepare and submit drawings of such to the Owner's Authorized Representative and obtain written approval before commencing work shown on these drawings.

B. Using proper width trencher chain, excavate a straight and true trench to a depth of 6-inches below pipe invert elevation for mainlines and 3-inches below pipe invert elevation for lateral lines.

C. Lateral lines may be pulled by a mechanical puller provided all other applicable specifications are met.

D. Loam encountered within the limits of trench excavation for irrigation mains and branch lines shall be carefully removed to the lines and depths as shown on the Drawings and stockpiled for subsequent replacement in the upper 6 inches of the trench from which it is excavated. Such removal and replacement of the quantities of loam shall be considered incidental to the irrigation system and no additional compensation will be allowed therefore.

E. Back filling shall be accomplished as follows: the first 10-inch of backfill material shall contain no foreign matter and no rock larger than 1 inch in diameter. Any material that is to come in contact with the pipes shall be less that 1/4" in diameter and shall be imported for this specific use. Carefully place material around pipe and wire and tamp in place. Remainder of backfill shall be laid-up in 6-inch (maximum) lifts and tamped to compaction with mechanical equipment matching adjacent undisturbed area. Frozen material shall not be used for backfill.

F. All excavation under walks and roadways shall be compacted to 95% and all excavation in lawn and shrub areas shall be compacted to no less than 90%.

G. All joints will be solvent welded, or made with threaded fittings. Use Teflon tape for threaded fittings.

H. Make all solvent-weld joints in strict accordance with manufacturer's recommendations, making certain not to apply an excess of primer or solvent, and wiping off excess solvent from each connection. Allow connections to set minimum 24 hours before pulling or pressure is applied to the system. Provide for expansion and contraction as recommended. Wire shall be laid in same trench as mainline and at pipe invert (see Wire Installation). All pipe joints shall be solvent welded together using IPS 70 Primer and IPS 711 cement.

I. Mainline pipe shall have minimum 18 inches of cover (excavate to invert as required by pipe size). Lateral pipe shall have minimum 12 inches of cover (excavate to invert as required by pipe size).

J. Cut plastic pipe with handsaw or pipe-cutting tool, removing all burrs at cut ends. All pipe cuts are to be square and true. Bevel cut end as required to conform to Manufacturer's Specifications.

K. Lines bordering curbs, buildings, or sidewalks shall be 12 inches away to allow for maintenance and access to the lines.

L. Every precaution shall be taken to prevent foreign material from entering the pipe while it is being placed in the trench. At times, when installation of the piping is not in progress, the open end(s) of the pipe shall be closed by a watertight plug or other means. All piping, which cannot temporarily be joined, shall be sealed to make as watertight as possible. This provision shall apply during the lunch hour as well as overnight. Pipe not to be installed that day shall not be laid out. Should water enter the trench during or after installation of the piping, no additional piping may be installed or back filled until all water is removed from the trench. Pipe shall not be installed when water is in the trench, when precipitation is occurring, or when the ambient temperature is at 35 degrees F or below. PVC pipe shall be snaked in the trench to accommodate for expansion and contraction due to changes in temperature.

M. When the pipe lines are connected but before any heads are installed, the control valves shall be opened and flushed with a full head of water to clean out the system.

N. Before trenches are backfilled all lines shall be pressurized and checked for leaks.

3.4 ELECTRONIC CONTROL VALVE ASSEMBLY INSTALLATION

A. Install valves as detailed. Control valves shall be installed on a level crushed stone base. Grade of base shall be consistent throughout. Valves shall be set plumb with adjusting handle and all bolts, screws and wiring accessible through the valve box opening.

B. Adjust zone valve operation after installation using flow control device on valve.

3.5 PIPE SLEEVING INSTALLATION

A. Sleeving shall be installed wherever piping is going under a non-soil area, generally where indicated on the Drawings. Minimum cover over all sleeving pipe shall be 18 inches as shown on the detail except where noted otherwise.

3.6 MAINLINE ISOLATION VALVE INSTALLATION

A. Mainline Isolation Valves: Install Resilient Wedge Gate valve as detailed in the locations shown on the drawings.

B. Ball Valves: Install isolation ball valve on mainline as detailed on the upstream side of each valve. Install isolation valve on a level crushed stone base so that they can be easily opened or closed.

3.7 VALVE BOX INSTALLATION

A. Furnish and install valve access boxes for electric valves, quick coupling valve, isolation valve, flushing valves, wire splices, etc.

B. Valve access boxes shall be installed on a minimum 6-inch crushed stone base. Finish elevation of all boxes shall be at grade except where noted. All crushed stone shall be supplied by the Contractor and installed before valve box. Crushed stone shall not be poured into previously installed valve boxes.

C. Valve boxes shall be set on a pressure treated wood frame or brick foundation which is placed on undisturbed soil. A 2" clearance must be maintained between the base of the valve and the crushed stone base.

D. Valve manifolds shall be set a minimum of 2" below top of the box including ball valves and quick couplers where called for. See the chart below for the number of valves allowed in each valve box. All valves must have ample room and access for repair.

Standard Valve Box	Not approved for use over valve boxes
Jumbo Valve Box	One Automatic Control Valve

E. Install valve boxes no closer than three feet from sidewalks, curbs, and all hard surfaced areas. Do not install valve boxes at the low point of the landscaping.

3.8 IRRIGATION HEAD INSTALLATION

A. All irrigation heads will be set perpendicular to the finished grade unless otherwise designated on the drawings and specifications. Rotor heads on hillsides will be adjusted to avoid cutting into the hill with the stream of water and causing excessive erosion.

B. All pop-up spray heads shall be installed on Flex swing pipe with 1/2" spiral barbed ells and one street ell as detailed.

3.9 SLEEVING INSTALLATION

A. Sleeving shall be installed wherever piping is going under a non-soil area, generally where indicated on the Drawings. Minimum cover over all sleeving pipe shall be 18 inches for all mainline and 12 inches for all lateral lines as shown on the detail except where noted otherwise. <u>Control wires shall be installed in a separate 2" sleeve.</u>

3.10 ELECTRICAL CONTROL WIRE INSTALLATION

A. Wiring shall be installed in the same trench as the main line wherever possible. Wires shall be laid alongside the pipe with multiple wire bundles cinched together at maximum 12-foot centers using plastic cable cinches and shall be laid at the same invert as the irrigation lines. Attach electrical wires every 15 feet with duct tape to the mainline. Provide an additional 8 inches to 12 inches slack at all changes of direction. Wiring in valve boxes shall be left with two feet of wire so that the valve solenoid, splice, and all connections can to be brought above grade for servicing without disconnecting the wires. This additional slack shall be coiled for neatness in the valve box.

B. Run two (2) extra wires each direction along the irrigation mainline through each valve box to the controller and label as “extra”.

C. Splices in electric control wires shall be soldered first and then fitted with a direct Bury Splice Kit. All splices shall be contained in a valve box, preferably the same box as the electric control valves. Do not run short pieces of wire.

D. It is important that the splice is absolutely waterproof so that there is no chance for leakage of water and corrosion build-up on the connection. All wiring shall be accomplished with as few splices as possible. Splice locations shall be shown on the Record Drawings.

E. All wire shall be laid in trenches and shall be carefully back-filled to avoid any damage to the wire insulation or wire conductors themselves. In areas of unsuitable material, the trench shall have a 2 inches layer of sand on the bottom before the wires are laid into the trench and back-filled. The wires shall have a minimum of 12 inches of cover. Wire not to be installed that day shall not be laid out.

F. An expansion curl shall be provided within 6 inches of each wire connection to a solenoid and at least every 100 feet of wire length on runs more than 100 feet in length. Expansion curls can be formed by wrapping five (5) turns of wire around a 1-inch diameter or larger pipe and then withdrawing the pipe.

G. Contractor shall provide a complete wiring diagram showing wire routing for the connections between the controller and valves. See section one for the inclusion of wiring diagram in operation and maintenance manuals.

3.11 CONTROLLER INSTALLATION

A. Install existing controller as detailed in the new location shown on the drawings. Coordinate final controller location with Owner’s Representative and Landscape Architect.

B. Contractor shall wire valves into existing controller and set proper program. Valves to be relocated may use existing wiring where possible.

3.12 QUICK COUPLER VALVE INSTALLTION

A. Install Quick Coupler Valves as detailed in locations shown on the drawings.

3.13 MANUAL DRAIN VALVE INSTALLATION

A. Install manual drain valves as detailed on irrigation mainlines at all low points to properly drain entire irrigation mainline.

3.14 CHECK / TEST / START-UP / ADJUST

A. Before any pipes are covered, the Owner's Authorized Representative shall inspect the system for compliance with specifications and drawings. Any required changes will be made at this time at no expense to the Owner.

B. Flushing: After all piping, and valves are in place and connected, flush piping under a full head of water.

C. Testing:

1. Leakage test: test all lines for leaks under operating pressure. Main lines shall be tested before backfill for a period of not less than one hour, and shall have no leakage or loss of pressure. If leakage is present, repair all leaks and re-test.
2. Coverage test: perform a coverage test in the presence of the Owner's Authorized Representative (notify Owner's Authorized Representative at least seven (7) days in advance of scheduled coverage test). Representative will determine if the water coverage is complete and adequate. Readjust heads and/or head locations as necessary or directed to achieve proper coverage.
3. All testing shall be at the expense of the Contractor.

3.15 CLEANING AND ADJUSTING

A. At the completion of the work, all parts of the installation shall be thoroughly cleaned. All equipment, pipe, valves and fittings shall be cleaned of grease, metal cuttings and sludge that may have accumulated by the operation of the system for testing.

B. Upon completion of all installation work, Contractor shall remove all leftover materials, equipment and debris resulting from work of this section from the site in a safe and legal manner.

C. Adjust valve boxes to grade as required.

D. After completion of grading, planting, and mulching, carefully adjust irrigation heads for proper watering.

E. Each control zone shall be operated for a minimum of 15 minutes and checked for consistency of delivering water. Valves, timing devices or other mechanical or electrical components, which fail to meet manufacture's standards, shall be rejected, replaced and tested until they meet the manufacturer's standards.

3.16 ACCEPTANCE AND OPERATION BY OWNER

A. Upon completion of the work and acceptance by the Owner, the Contractor shall be responsible for the training of the Owner's Authorized Representative(s) in the operation of the system (provide minimum 48 hours written notice in advance of test). The Contractor shall furnish the Record Drawings and operational manuals prior to acceptance by the Owner. The Contractor shall guarantee all parts and labor for a minimum period of one (1) year from date of acceptance.

B. It will be the responsibility of the Contractor to work with the Owner's maintenance personnel and winterize the system in the fall. It will also be their responsibility to help activate system in the spring and make sure there are no problems.

3.17 GUARANTEE

A. All work shall be guaranteed for compliance with the drawings and specifications for a period of one year after the date of substantial completion. The Contractor shall correct any deficiencies when notified during the warrantee period and correct in satisfactory condition any damage to the buildings or grounds, without cost to the Owner. All guarantees shall be in writing and approved by the Owner's Authorized Representative before submitting to the Owner.

B. RECORD IRRIGATION DRAWINGS maintained by the Contractor shall be furnished to the Owner's Authorized Representative before the time of the Systems Inspection and before any Substantial Completion Date will be issued.

C. Provide first year backflow testing and certification to the Owner.

END OF SECTION 328400

SECTION 329000 - EXTERIOR PLANTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
   1. Trees
   2. Shrubs
   3. Perennials
   4. Groundcover
   5. Fertilizers
   6. Mulch
   7. Metal Edging
   8. Miscellaneous Products

B. Related Sections include the following:
   1. Division 31 – Earthwork for excavation, filling, rough grading, backfill materials, protection of existing trees and plantings, and site clearing.
   2. Specification Section 328400 – Irrigation Systems.
   3. Specification Section 329119 – Fine Grading and Soil Preparation

1.3 SCOPE

A. The extent of the landscape development work is shown on the drawings and in schedules and includes all plant materials, preparation of planting pits and beds, and mulch as indicated.

B. The Contractor shall visit the site and study all portions of the Contract Documents prior to submitting a bid.

C. As-built Drawings: The Contractor shall keep a record of all departures from the contract drawings that occur during construction. These shall be kept on a clean set of prints of the contract drawings. The Owner's Authorized Representative will review the "as-built drawings" to verify that changes are being recorded as construction occurs.

1.4 DEFINITIONS

A. Balled and Burlapped Stock: Exterior plants dug with firm, natural balls of earth in which they are grown, with ball size not less than diameter and depth recommended by ANSI Z60.1 for type and size of tree or shrub required; wrapped, tied, rigidly supported, and drum-laced as recommended by ANSI Z60.1.

B. Balled and Potted Stock: Exterior plants dug with firm, natural balls of earth in which they are grown and placed, unbroken, in a container. Ball size is not less than diameter and depth recommended by ANSI Z60.1 for type and size of exterior plant required.

C. Container-Grown Stock: Healthy, vigorous, well-rooted exterior plants grown in a container with well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for kind, type, and size of exterior plant required.

D. Finish Grade: Elevation of finished surface of Planting Soil Mix prior to applying mulch.

E. Planting Soil Mix: Native or imported topsoil, manufactured topsoil, or surface soil modified to become topsoil; mixed with soil amendments.

F. Subgrade: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill, before placing planting soil.

1.5 EXISTING UTILITIES

A. Before any trenching, excavation, or digging below the surface for any reason is begun, the Contractor shall contact the owner, Blue Stakes, and all other necessary entities in order to determine as close as possible the location of all underground utilities and structures. Although identified, underground utilities and structures will be assumed to be in approximate locations. The Contractor will conduct the work in such a manner to protect all utilities and structures from damage. It is the responsibility of the Contractor to repair or replace any damage incurred by the Contractor or the Contractor's employees with identical materials to match the existing, at no expense to the Owner.

1.6 PROTECTION OF EXISTING SITE IMPROVEMENTS

A. The Contractor shall take necessary precautions to protect site improvements to remain, including, but not limited to buildings, grounds, or utilities. Should damage be incurred by the Contractor or the Contractor's employees, the Contractor shall repair the damage to its original condition at the Contractor's own expense.

1.7 ORDINANCES, PERMITS, AND FEES

A. The Work under this Section shall comply with all ordinances and regulations of authorities having jurisdiction.

B. The Contractor shall obtain and pay for any and all permits, tests and certifications required for the execution of Work under this Section.

C. Furnish copies of Permits, Certifications and Approval Notices to the Owner's Representative prior to requesting payment.

D. The Contractor shall initiate a "Request for Shutdown" any time a utility must be shut off to allow work progress. See the General Conditions for "Request for Shutdown" requirements.

1.8 SUBMITTALS

A. Product Data: For each type of product indicated.
   1. Provide documentation that **all trees** are available and secured within 30 days of contractor receiving notice to proceed.
   2. Product info for metal edging, tree anchoring systems, and root barrier.

B. Samples for Verification: For each of the following
   1. Soil Aid/Soil Pep Fine Texture Mulch – 1 gallon zip lock bag sample of bark mulch, identifying source, including name and telephone number of supplier.
   2. Grey Stone Mulch 1 gallon zip lock bag minimum sample of Stone, identifying source, including name and telephone number of supplier.

C. Product Certificates: For each type of manufactured product, signed by product manufacturer, and complying with the following:
   1. Manufacturer's certified analysis for standard products.
   2. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.

D. Qualification Data: For landscape installer.

E. Planting Schedule: Prepare a proposed planting schedule. Schedule the dates for each type of landscape work during the normal seasons for such work in the area of the site. Correlate work with specified maintenance periods to provide maintenance throughout the specified time period. Once accepted, revise dates only as approved in writing, after documentation of reasons for delays.

F. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of exterior plants during a calendar year. Submit before expiration of required maintenance periods.

1.9 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful establishment of exterior plants.
   1. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when exterior planting is in progress.
   2. Qualification of Arborist: All work of pruning shall be performed by an arborist certified by the International Society of Arboriculture.

B. Provide quality, size, genus, species, and variety of exterior plants indicated, complying with applicable requirements in ANSI Z60.1, "American Standard for Nursery Stock."

C. Tree and Shrub Measurements: Measure according to ANSI Z60.1 with branches and trunks or canes in their normal position. Do not prune to obtain required sizes. Take caliper measurements 6 inches above ground for trees up to 4-inch caliper size, and 12 inches above ground for larger sizes. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip-to-tip.

D. Representative Plant photographs: The contractor shall provide actual photographs (one photograph minimum per plant species, variety, and/or cultivar), obtained from the plant source for each plant listed in the plant schedule to show representative standards of quality and compliance with the contract requirements. Plants shall be photographed with a person or some type of measuring device included in the photo to provide scale. Approval of the photographed plant materials does not constitute final acceptance. Plant material will be observed and inspected at the job site.

E. Plant Observation: After approval of plant photographs, Landscape Architect shall observe trees and shrubs, and other plant material at job site for compliance with requirements for genus, species, variety, size, and quality. Landscape Architect retains right to observe trees and shrubs further for size and condition of balls and root systems, insects, injuries, and latent defects and to reject unsatisfactory or defective material at any time during progress of work. Trees with cut central leaders, split leaders, or crooked trunks will be rejected. Remove rejected plant materials immediately from Project site. Cost of replacements and project delays shall be borne by the Contractor. All trees approved for the project will be individually tagged with the Landscape Architect's seals at the job site, and no trees shall be planted without such seals.

F. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.10 DELIVERY, STORAGE, AND HANDLING

A. Notify Landscape Architect 7 days prior to the proposed arrival of plant material on site.

B. Plant materials shall be examined by Landscape Architect at time of delivery on site. This inspection does not constitute final acceptance of plants. All plants will be inspected again at time of final inspection and once again at the end of the warranty period. Any plant found to be unacceptable at any of these inspections shall be immediately removed and replaced.

C. Do not prune trees and shrubs before delivery, except as approved by Landscape Architect. Protect bark, branches, and root systems from sun scald, drying, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of exterior plants during delivery. Do not drop exterior plants during delivery.

D. Handle planting stock by root ball.

E. Deliver exterior plants after preparations for planting have been completed and install immediately. If planting is delayed more than six hours after delivery, set plants in shade, protect from weather and mechanical damage, and keep roots moist.
   1. Set nursery stock on ground and cover roots with mulch.
   2. Do not remove container-grown stock from containers before time of planting.
   3. Water root systems of exterior plants stored on-site as often as necessary to maintain root systems in a moist condition.

1.11 COORDINATION

A. Planting Restrictions: Plant during the following period. Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.
   1. April 15 to October 31.

B. Weather Limitations: Planting shall not take place when ground is frozen or covered in snow.

C. Coordination with Lawns: Plant trees and shrubs after finish grades are established and before planting lawns, unless otherwise acceptable to Landscape Architect.

1.12 JOB CONDITIONS

A. Examine the subgrade, verify the elevations to be no more than plus or minus 2” above or below subgrade elevation which should allow for the depths required for topsoil and mulch throughout the planted areas. Observe the conditions under which work is to be performed, and notify the Landscape Architect of unsatisfactory conditions.
   1.
   2. Excavation:When conditions detrimental to plant growth are encountered, such as rubble fill, adverse drainage conditions, or obstructions, notify the Landscape Architect for direction prior to planting.
   3.

B. Proceed with and complete the landscape work as rapidly as portions of the site become available, working within the seasonal limitations for each kind of landscape work required.

1.13 WARRANTY

A. Special Warranty: Warrant the following exterior plants, for the warranty period indicated, against defects including death and unsatisfactory growth, except for defects resulting from lack

of adequate maintenance, neglect, or abuse by Owner, or incidents that are beyond Contractor's control.

1. Warranty Period for Trees and Shrubs: One year from date of Substantial Completion.
2. Warranty Period for Ground Cover and Plants: One year from date of Substantial Completion.
3. Remove dead exterior plants immediately. Replace immediately unless required to plant in the succeeding planting season.
4. Replace exterior plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.

1.14 MAINTENANCE

A. Trees and Shrubs: Maintain for the following maintenance period by pruning, cultivating, watering, weeding, fertilizing, restoring planting saucers, tightening and repairing stakes and guy supports, and resetting to proper grades or vertical position, as required to establish healthy, viable plantings. Spray as required to keep trees and shrubs free of insects and disease. Restore or replace damaged tree wrappings.

1. Maintenance Period: A period of any four consecutive growing months (growing months defined as April, May, June, July, August, and September) from date of Substantial Completion.

B. Ground Cover and Plants: Maintain for the following maintenance period by watering, weeding, fertilizing, and other operations as required to establish healthy, viable plantings:

1. Maintenance Period: A period of any four consecutive growing months (growing months defined as April, May, June, July, August, and September) from date of Substantial Completion from date of Substantial Completion.

1.15 SUBSTANTIAL COMPLETION

A. The date of Substantial Completion for the new landscape will be when the Maintenance and Operating Manual has been approved, all required submittals have been received and approved, and the planting is installed as intended as demonstrated during final inspection. This will be determined by observation by the Landscape Architect and Owner’s Representative.

1.16 INSPECTIONS

A. The Contractor shall request a site inspection with the Landscape Architect and Owner’s Authorized Representative at the time of the Substantial Completion and again at the end of the warranty period. Inspections will verify compliance to the drawings and specifications. Any items not complying with the drawings and specifications shall be adjusted and/or repaired prior to issuing Substantial Completion or Final Acceptance.

1. The Landscape Architect shall be given a minimum of 7 days notice prior to the site inspections.

PART 2 - PRODUCTS

2.1 TREE AND SHRUB MATERIAL

A. General: Furnish nursery-grown trees and shrubs complying with ANSI Z60.1, with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock free of disease, insects, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.

B. Grade: Provide trees and shrubs of sizes and grades complying with ANSI Z60.1 for type of trees and shrubs required.

C. Size and Planting Condition: As indicated on Drawings.

D. Label each tree and shrub with securely attached, waterproof tag bearing legible designation of botanical and common name.

2.2 SHADE AND FLOWERING TREES

A. Shade Trees: Single-stem trees with straight trunk, well-balanced crown, and intact leader, of height and caliper indicated, complying with ANSI Z60.1 for type of trees required.

B. Small Ornamental Trees: Branched or pruned naturally according to species and type, with relationship of caliper, height, and branching according to ANSI Z60.1; stem form as indicated on Drawings.

C. Multistem Trees: Branched or pruned naturally according to species and type, with relationship of caliper, height, and branching according to ANSI Z60.1; stem form as indicated on Drawings.

2.3 DECIDUOUS SHRUBS

A. Form and Size: Deciduous shrubs with not less than the minimum number of canes required by and measured according to ANSI Z60.1 for type, shape, and height of shrub.

2.4 CONIFEROUS EVERGREENS

A. Form and Size: Normal-quality, well-balanced, coniferous evergreens, of type, height, spread, and shape required, complying with ANSI Z60.1.

2.5 BROADLEAF EVERGREENS

A. Form and Size: Normal-quality, well-balanced, broadleaf evergreens, of type, height, spread, and shape required, complying with ANSI Z60.1.

2.6 PERENNIALS

A. Form and Size: Provide healthy, field-grown plants from a commercial nursery, of container size, species and variety shown or listed and complying with requirements of ANSI Z60.1.

2.7 VINES

A. Vines: Provide vines of container size and species indicated complying with requirements in ANSI Z60.1.

2.8 GROUND COVER PLANTS

Ground Cover: Provide ground cover of species indicated, established and well rooted in pots or similar containers, and complying with ANSI Z60.1.

2.9 FERTILIZER

A. Commercial Fertilizer: Commercial-grade complete fertilizer, O-F-241C, type 1, grade 16-16-8, level B with guaranteed chemical analysis of contents marked on the containers.

B. Planting Tablets: Fertilizer planting tablets shall be tightly compressed commercial grade planting tablets having a 20-15-5 formula, weighing 21 grams each, as "Blue Chip," "Grow-Power" planting tablets or "approved equal." The planting tablets shall be delivered to the site in the original, unopened containers, bearing the manufacturer's guaranteed analysis. Any damage tablet will not be accepted.

2.10 MULCHES

A. 5/8" Grey Brown Basalt "Permebark available through Grass Roots Agronomics, Inc., or approved equal. Contact: Robert Parrish, (208) 365-1246

B. Soil Aid/Soil: Fine textured soil aid or soil pep mulch. Submit sample for approval prior to placement.

2.11 METAL EDGING

A. Metal Edge Restraints: Permaloc Aluminum "Asphalt Edge" with Mill Finish (raw). Install 4" Install per manufactures instructions. Contact Robert J. Kimball at Permaloc Corp. at Ph. 800.356.9660 or e-mail Rob.Kimball@Permaloc.com

2.12 STAKES AND GUYS

A. Tree stakes shall be two inch (2") diameter, by ten foot (10') long straight grained pine and driven to a minimum depth of one foot (1') into firm soil beneath plant pit excavation. Height of stakes shall be below tree branching.

B. Tree ties shall be VIT steel twist brace attached to stake with 1- ¼" galvanized threaded nails. Field sample shall be approved by the Owner's Representative

C. Guy wires and anchors on all evergreens and trees 4"Cal or larger shall be duckbill tree support system model # 68 DTS including anchors, galvanized steel, vinyl-coated cable, turnbuckles, tree collars and cable clamps, all pre-assembled. Install per manufacturer's specifications.

D. Safety flagging for all diagonal guy wires shall consist of one half-inch (1/2") PVC sleeves.

2.13 MISCELLANEOUS PRODUCTS

A. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees and shrubs. Deliver in original, sealed, and fully labeled containers and mix according to manufacturer's written instructions.

B. Herbicide:
   1. Provide selective post emergent herbicide for use in weed control. Provide Round-up or approved equal.
   2. Provide pre-emergent herbicide for use in planter beds for weed control. Provide Treflan or approved equal.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive exterior plants for compliance with requirements and conditions affecting installation and performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Locate all underground utilities prior to digging. Do not place plants on or near utility lines. Obtain a digging permit and have the permit at the site.

B. Protect structures, utilities, sidewalks, pavements, and other facilities, and lawns and existing exterior plants from damage caused by planting operations.

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 walkways.

D. Lay out individual tree and shrub locations and areas for multiple exterior plantings. Acceptance of plant layout must be obtained from Landscape Architect prior to planting. The Landscape Architect shall be given a minimum of 7 days notice prior to inspecting planting layouts. Make adjustments as required by Landscape Architect.

E. Apply antidesiccant to trees and shrubs using power spray to provide an adequate film over trunks, branches, stems, twigs, and foliage to protect during digging, handling, and transportation.

3.3 PLANTING BED ESTABLISHMENT

A. Prepare subgrade of planting beds and spread Planting Soil Mix in accordance with specification section 329119 - Fine Grading and Soil Preparation.

B. Finish Grading: Grade planting beds to a smooth, uniform surface plane with loose, uniformly fine texture and in accordance with specification section 329119 – Fine Grading and Soil Preparation. Roll and rake, remove ridges, and fill depressions to meet finish grades prior to adding mulch.

C. Restore planting beds if eroded or otherwise disturbed after finish grading and before planting.

D. Install Landscape Edging as detailed in all location shown on the drawings.

3.4 TREE AND SHRUB EXCAVATION

A. Pits and Trenches: Excavate circular pits with sides sloped inward. Do not further disturb base. Scarify sides of plant pit smeared or smoothed during excavation.

B. Obstructions: Notify Landscape Architect if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.

C. Prior to planting, fill excavated tree/shrub pit with water and allow to percolate out. If after 24 hours, the water has not percolated out of the pit, notify the Owner's Authorized Representative. Do not plant until the problem has been corrected.

3.5 TREE AND SHRUB PLANTING

A. Set balled and burlapped stock plumb and in center of pit or trench with top of root ball 1"-2" above adjacent finish grades.
   1. Remove burlap, wire baskets, twine, and wrappings from root balls, taking care not to disturb root balls. Do not use planting stock if root ball is cracked or broken before or during planting operation.
   2. Place Planting Soil Mix around root ball in 12 inch lifts, tamping to settle mix and eliminate voids and air pockets. When pit is approximately one-half backfilled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed. Water again after placing and tamping final layer of Planting Soil Mix.

B. Set container-grown stock plumb and in center of pit or trench with top of root ball flush with adjacent finish grades.
   1. Carefully remove root ball from container without damaging root ball or plant.
   2. Place Planting Soil Mix around root ball in layers, tamping to settle mix and eliminate voids and air pockets. When pit is approximately one-half backfilled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed. Water again after placing and tamping final layer of Planting Soil Mix.

C. Add fertilizer plant tablets to planting pit. Fertilizer tablets shall be placed no deeper than eight inches (8") from finished grade and two inches (2') from the root ball. Add the required number of tablets as specified below.
   1. One (1) tablet per one (1) gallon container.
   2. Two (2) tablets per five (5) gallon container.
   3. Three (3) tablets per fifteen (15) gallon container.
   4. Four (4) tablets per two-inch (2") caliper tree.
   5. Six (6) tablets per three-inch (3") caliper tree.
   6. Eight (8) tablets per four-inch (4") caliper tree.
   7.

D. Prepare a watering basin around the trunk as indicated on Drawings.

E. Mulching: Apply specified thickness of mulch extending to edge of planting pit or trench. Do not place mulch within 4 inches of trunks or stems.

3.6 TREE AND SHRUB PRUNING

A. Pruning shall be limited to the minimum necessary to remove dead or injured twigs and branches. All cuts, scars and bruises shall be properly treated according to the directions of the Landscape Architect. Proper pruning techniques shall be used. Do not leave stubs and do not cut the dominant leader branch. Improper pruning shall be cause for rejection of plant material.

3.7 GUYING AND STAKING

A. Except in rare cases trees should not be staked. Stake and guy trees only when indicated by site conditions and approved by Landscape Architect.

B. Upright Staking and Tying: As detailed, trees shall be firmly staked, as shown on the Drawings. Stakes shall be of even height and neat in appearance, and shall not injure the root balls.

C. Guying and Staking: As detailed, trees shall be firmly anchored and guyed as shown on the Drawings.

3.8 GROUND COVER, VINE, AND PERENNIAL PLANTING

A. Set out and space ground cover and plants as indicated.

B. Dig holes large enough to allow spreading of roots, and backfill with planting soil.

C. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.

D. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.

E. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

F. Refer to Erosion Control specifications for Groundcover areas.

3.9 PLANTING BED MULCHING

A. Mulch backfilled surfaces of planting beds and other areas indicated on drawings.
   1. Mulch: Apply stone mulch or soil aid/soil pep to depths as indicated on the drawings. Do not place mulch against plant stems. Do not place mulch against plant stems. Care shall be taken not bury any plants. Plant lost due to mulch coverage shall be replaced at the Contractor's expense.

3.10 HERBICIDE APPLICATION AND WEED CONTROL

A. Application of pre-emergent herbicide is required. The Contractor shall maintain the site weed free until the end of the establishment period.

B. Apply herbicides so no damage to protected vegetation occurs whether inside or outside the project site. Damage to protected vegetation or vegetation outside the project site will be reimbursed to the Owner or replaced by the Contractor in a manner satisfactory to the Owner's Authorized Representative, and according to the International Society of Arboriculture Method of "Valuation for Landscape Trees, Shrubs, and Other Plants," latest edition.

C. Post-Emergent Herbicide:
   1. Mix and apply post-emergent herbicide according to manufacturer's recommendations indicated in the "Weeds Controlled" section of the label, and apply to undesired, actively growing vegetation.
   2. Apply the spray mixture so that all undesired vegetation is uniformly covered, but avoid causing over-spray and drift. Spray target vegetation so that it is wet, but short of run-off.
   3. Prune all suckers at the base of any trees to the soil level prior to application.
   4. Do not apply post-emergent herbicide in any of these conditions: When rainfall is expected within six hours; when there is growth stress as a result of drought, insects, disease, or plant damage, or when there is heavy dust on plants.
   5. Do not walk or permit other traffic on treated areas when they are wet from application. Shoes and equipment may track spray solution to areas where vegetation is not to be treated.
   6. Repeat application, as necessary to completely eradicate undesired vegetation.

D. Pre-emergent Herbicide:

1. Mix and apply pre-emergent herbicide according to manufacturer's recommendations and information on the side panel, and the following: Use granular applicators designed to apply herbicide at Manufacturer's suggested highest rate.
2. Calibrate the applicator according to the manufacturer's directions prior to use and check frequently during application to be sure the equipment is working properly and distributing the granules uniformly. Do not apply more than the recommended amount.
3. Apply granular herbicide according to manufacturer's recommendations and on site conditions and soil preparation requirements or restrictions appropriate to the herbicide used.
4. The pre-emergent application must be followed within 8 hours with overhead watering or rainfall equivalent to 1/2".

E. License: Use a state licensed applicator to apply herbicide.

F. Mechanical Control:
1. Mechanically control the weeds by pulling, cutting, hoeing, or by any other directed means approved by the Owner's Authorized Representative.
2. Weeds in a dormant stage or other condition which cannot be effectively controlled with post-emergent herbicide shall be removed from the site by mechanical methods.

3.11 ESTABLISHMENT AND MAINTENANCE

A. Begin maintenance immediately after planting.

B. Maintain plant until Final Acceptance but in no case less than four (4) consecutive growing months after Substantial Completion and throughout the Establishment Period.

C. Maintain plants by watering, pruning, cultivating and weeding as required for healthy growth. Restore watering basins. Treat as required to keep plant materials free of insects and disease.

D. The Contractor shall provide the Owner with an approved irrigation schedule.

E. The Contractor shall provide on-site maintenance instructions to the Owner's Authorized Representative and maintenance personnel prior to turning the project over to the Owner.

3.12 CLEANUP AND PROTECTION

A. During exterior planting, keep adjacent pavings and construction clean and work area in an orderly condition.

B. Protect exterior plants from damage due to landscape operations, operations by other Contractors and trades, and others. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged exterior planting.

3.13 DISPOSAL

A. Disposal: Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION 329000

SECTION 329119 - FINE GRADING AND SOIL PREPARATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Related Sections include the following:

1. Section 329000 – Planting
2. Section 329223 – Sodding

1.3 SUBMITTALS

A. At least 30 days prior to ordering materials, the Contractor shall submit to the Landscape Architect representative samples, certifications, manufacturer's literature and certified test results for all materials as specified below. No materials shall be ordered or delivered until the required submittals have been reviewed and stamped approved by the Landscape Architect. Delivered materials shall match the approved samples.

B. Approval shall not constitute final acceptance. The Landscape Architect reserves the right to reject, on or after delivery, any material that does not meet these Specifications.

C. List of submittals required.

1. Sample of manufactured Planting Soil Mix and soil analysis testing results.
2. Sample of topsoil (component of the Planting Soil Mix) and soil analysis testing results
3. Sample of organic compost (component of the Planting Soil Mix) and sieve analysis.
4. Sample Expanded Shale Fines Soil Conditioner (component of the Planting Soil Mix) and product data.

1.4 QUALITY ASSURANCE

A. The following standards apply to the work of this Section:

1. AOAC: Association of Official Agricultural Chemists.
2. ASA: Methods of Soils Analysis, American Society of Agronomy, Soil Science Society of America, Inc., Madison Wisconsin, latest edition.
3. American Society for Testing and Materials (ASTM).

4. All applicable local codes and regulations.

B. It is the intent of this specification that all materials herein specified and shown on the drawings shall be of the highest quality available and meeting the requirements specified.

C. The work of this Section shall be performed by a Contracting firm that has successfully installed work of a similar quality, schedule requirement, and construction detailing with a minimum of five (5) years experience.

D. All work shall be performed in accordance with the best standards of practice relating to the trade and under the continuous supervision of a competent foreman capable of interpreting the Drawing and Specifications.

E. Soil shall not be worked when moisture content is so great that excessive compaction occurs, nor when it is so dry, that dust will form in air or that clods will not break readily. Water shall be applied, if necessary, to provide ideal moisture content for tilling and for planting.

F. All accumulated debris and rubbish shall be cleaned up and removed from the site before commencing work. Clear and grub all dead vegetative matter. The site shall be weed free prior to proceeding with any work.

G. Soil-Testing Laboratory Qualifications: An independent laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.

H. Topsoil Analysis: Furnish a soil analysis for all topsoil proposed for use as specified in this section by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; sodium absorption ratio; deleterious material; pH; and mineral and plant-nutrient content of 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 satisfactory topsoil.

I. Compost Testing Laboratory Qualifications: An independent, with the experience and capability to conduct testing indicated following U.S. Composting Council Seal of Testing Assurance procedures, or equivalent.

J. Compost Analysis: Provide documentation from supplier that compost has reached monitored temperature of 140 degrees Fahrenheit for at least one week.

1. Test representative sample(s) of compost for the following parameters: pH, soluble salts, percent moisture, percent organic matter, particle size, and nutrient content, including: Nitrogen (N), Phosphorus (P), Potassium (K), Calcium (Ca), and Magnesium (Mg).

2. Test compost for maturity. Provide Carbon-Nitrogen ratio.

1.5 JOB CONDITIONS

A. Examine the subgrade, verify the elevations to be no more than plus or minus 2" above or below subgrade elevation which should allow for the depths required for topsoil and mulch throughout the planted areas. Observe the conditions under which work is to be performed, and notify the Landscape Architect of unsatisfactory conditions.

PART 2 - PRODUCTS

2.1 PLANTING SOIL MIX

A. Planting Soil Mix: Shall consist of a ratio by volume of 50 percent topsoil, 25 percent organic compost, and 25 percent Expanded Shale Fines Soil Conditioner.

1. The Contractor shall provide Planting Soil Mix at locations and depths indicated on the Drawings to complete all planting areas, as specified in this Section and as directed by the Landscape Architect. Planting Soil Mix shall be produced by homogeneously blending the specified components prior to placement.
2. Do not commence with mixing Planting Soil Mix until the review and approval of soil test results, organic compost certification submittal, and expanded shale fines soil conditioner submittal.

2.2 TOPSOIL

A. Native or Imported topsoil used as a component of the Planting Soil Mix for turf areas, plant beds, and tree planting pits. Submit soil test results certifying that the topsoil meets the texture and analysis outlined below. Topsoil not meeting the outlined criteria will not be accepted.

1. Source: Topsoil will be obtained from the following sources:
   a. Imported from naturally well-drained areas with a history of satisfactory vegetative growth that has not been stripped before.

B. Topsoil shall be "fine sandy loam" or "sandy loam" determined by mechanical analysis (ASTM D-22) and based on the "USDA Classification System."

C. Topsoil shall not contain less than four percent (4%) or more than eight percent (8%) organic matter as determined by the loss on ignition of oven-dried samples.

D. The acidity range of the topsoil shall be pH 5.5 to 7.5.

E. Topsoil shall be free of stones 1-1/2 inch or larger in any dimension and other extraneous materials harmful to plant growth. Soluble salts <2 (dS/m or mmho/cm) and sodium absorption ration (SAR) <3. The electrical conductivity (EC2) of a 1:2 soil-water suspension shall be equal to or less than 1.0 millimhos/cm. (Test minus sieve Number 10 material).

F. No topsoil shall be delivered to the site or placed in planting areas until topsoil test results and recommendations have been reviewed and approved by the Landscape Architect. Such approval shall not constitute final acceptance. The Landscape Architect shall reject any material delivered to the site, which, after on-site, post-delivery testing, does not meet these specifications.

2.3 ORGANIC SOIL AMENDMENTS

A. Compost: Well-composted, stable, and weed-free organic matter, pH range of 6 to 8; moisture content 25 to 35 percent by weight; 100 percent passing through 1/2-inch sieve; soluble salt content of <5 dS/m or mmho/cm; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings.

B. Compost shall conform as follows:

1. Tested at minimum, every six months for noxious weeds.
2. Organic matter source (feedstock): Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.
3. Organic Matter Content: 60 to 80 percent of dry weight as determined by ash method.
4. Free of refuse (less than 1 percent by dry weight), plastics, contaminants or any material toxic to plant growth.
5. Processed to meet U.S. Composting Council's Seal of Testing Assurance Program, or equivalent.
6. Carbon to Nitrogen Ratio: 40 to 1 or lower.
7. Composted for a minimum of 9 months and reach a monitored temperature of 140 degrees Fahrenheit for at least one week.

Toxic Elements	Maximum Concentration (mg/kg dry weight)
Arsenic	41
Cadmium	39
Copper	1500
Lead	300
Mercury	17
Molybdenum	75
Nickel	420
Selenium	36
Zinc	2800

2.4 EXPANDED SHALE FINES SOIL CONDITIONER

A. Expanded Shale Fines Soil Conditioner: shall be fines graded (passing #4 Sieve), pre-consumer recycled material consisting of lightweight, porous ceramic particles produced by expanding and vitrifying select shale rock in rotary kilns.

B. Basis of Design: Subject to compliance with requirements, provide Utelite Fines or comparable product by one of the following:

1. Utelite Corporation– Coalville, UT. Contact Scott Jenson, (801) 243-9348.
2. Texas Industries – (713) 329-2600
3. Buildex, Inc. – (785) 242-2177
4. Big River Industries – (800) 342-5483

PART 3 - EXECUTION

3.1 PREPARATION

A. Planting Soil Mix placement shall not commence until rough grades have been approved by the Landscape Architect.

B. The Contractor shall remove existing soil and replace with Planting Soil Mix in turf, and planting bed areas, and plant pits as specified in this section and as directed by the Landscape Architect.

C. Placement of Planting Soil Mix:

1. Immediately prior to placing and spreading the Planting Soil Mix loosen the subgrade of planting beds to a minimum depth of SIX inches (6”). Remove all stones greater than 3/4" in diameter and all weeds, sticks, debris, or rubbish. Such material shall be removed from the site and legally disposed.
2. Spread Planting Soil Mix over loosened subgrade to the depth indicated on the drawings. Do not spread Planting Soil Mix if subgrade is frozen, muddy, or excessively wet.

D. Planting Soil Mix shall be backfilled in lifts of no more than six inches (6”). Compact each lift by tamping to 85% prior to placing next layer of backfill.

E. Add recommended soil amendments at rates specified in soil analysis recommendations and as directed by the Landscape Architect. Rototill amendments into the top 6 inches of soil to achieve a uniform mixture.

1. Following the incorporation of soil amendments, the surface shall be re-compacted to meet the requirements of this section.

3.2 FINE GRADING

A. When rough grading, weeding, soil preparation and soil amending have been completed, and soil has been thoroughly water settled, all planting areas should be smoothly graded, ready for placement of plant materials.

B. Fine grading shall be done when soil is at optimum moisture content.

C. Finish grades shall be smooth, even and on a uniform plane with no abrupt changes of surface. The finish grade shall not vary more than one half inch (1/2”) in ten feet (10’) from the required

line, and grade set forth in the Drawings. Adjustments of finish grades shall be made at direction of Landscape Architect as required.

D. Finish grade of mulch in shrub and groundcover areas shall be flush with paved surfaces, after top-dressed with specified thickness of mulch. Finish grade of soil in all turf areas shall be one inch (1") below all paved surfaces before laying sod.

END OF SECTION 329119

SECTION 329223 - SODDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Furnish and install sodded lawn as described in Contract Documents, for all lawn areas.

B. Related Sections include the following:

1. Section 329119 – Fine Grading and Soil Preparation
2. Section 328400 – Irrigation
3. Section 329000 – Planting
4. Section 329219 – Seeding

1.3 QUALITY ASSURANCE

A. The work of this Section shall be performed by a Contracting firm, which has successfully installed work of a similar quality, schedule requirement, and construction detailing with a minimum of five (5) years experience. Proof of experience shall be submitted per Samples, Submittals & Testing, refer to Section 1.5.

B. All work shall be performed in accordance with the best standards of practice relating to the trade and under the continuous supervision of a competent foreman capable of interpreting the Drawings and Specifications.

C. All accumulated debris and rubbish shall be cleaned up and removed from the site before commencing work. Clear and grub all dead vegetative matter. The site shall be weed free prior to proceeding with any work.

D. Pre-Installation Meetings

1. Participate in pre-installation meetings.

1.4 STANDARDS AND DEFINITIONS

A. The following standards and definitions shall apply to the work of this Section.

1. AOAC: Association of Official Agricultural Chemists
2. ASPA: American Sod Producers Specifications for Turfgrass Sod Materials and Transplanting/ Installing.
3. ASTM: American Society for Testing and Materials

1.5 SAMPLES AND SUBMITTALS

A. At least thirty (30) days prior to intended use, the Contractor shall provide the following samples and submittals for approval. Do not order materials until Landscape Architect's approval of samples, certifications, or test results has been obtained. Delivered materials shall closely match the approved samples.

1. Sod: Submit a supplier's certificate showing sod composition by grass species conforms to the Specification requirements for each type of sod. Certification shall identify the source and include the name and telephone number of the supplier.

B. Maintenance Instructions: At the time of Acceptance, the Contractor shall submit complete maintenance instructions for lawn care for the Owner's use. The instructions shall be reviewed for approval by the Landscape Architect as a pre-condition for Acceptance.

1.6 DELIVERY, STORAGE, & HANDLING

A. Harvest, deliver, store, and handle sod in accordance with requirements of "American Sod Producers (ASPA) Specifications for Turfgrass Sod Materials and Transplanting/ Installing."

B. During wet weather, allow sod to dry sufficiently to prevent tearing during lifting and handling.

1. During dry weather, protect sod from drying. Water as necessary to insure vitality and to prevent excess loss of soil in handling.
2. Sod which dries out will be rejected.

1.7 COORDINATION

A. Planting Restrictions: Plant during the following period. Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.

1. April 15 to October 15.

B. All newly sodded areas shall be rolled as specified immediately after sod has been laid.

1.8 LAWN MAINTENANCE AND ESTABLISHMENT PERIOD

A. Begin maintenance immediately after each area is sodded and continue until acceptable lawn is established, but for not less than the following periods:

1. Sodded Lawns: 90 days from date of Substantial Completion throughout growing months (April 15th to October 15th). In the event the maintenance period is not completed

before the end of the growing months then the maintenance period shall be carried over to the next year and start back up April 15th.

2. Maintain and establish lawn by watering, fertilizing, weeding, mowing, trimming, replanting, and other operations. Roll, re-grade, and replant bare or eroded areas and re-mulch to produce a uniformly smooth lawn.

B. 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 2 inches for the first two weeks after planting. Water at the rate given in the turfgrass vendor's written recommendations thereafter during the maintenance period.

1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.

C. Mow lawn as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than 30 percent of grass height. Remove no more than 30 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 Low Water Use Blue Grass 3 inches high. Once established, mowing should only be required monthly at most.

D. Low Water Use Blue Grass Post fertilization: Apply fertilizer in accordance with supplier's fertilizer recommendations.

1. Use 16-16-16 fertilizer mixture or as recommended by supplier, applying one pound per 1,000 square feet of actual nitrogen, 4 percent phosphorus and 2 percent potassium, by weight using the same mix until maintenance period is over.

1.9 FINAL INSPECTION

A. Within 10 days of the end of the establishment period written notice requesting an inspection shall be submitted to the Project Landscape Architect by the Contractor. Three days shall be allowed for notification to those persons invited to attend prior to the inspection date. All areas designated for grass or lawn on the plans shall be covered with a reasonable stand of grass and acceptable to the Project Landscape Architect. All areas found not to be acceptable shall be reseeded in accordance with the above re-seeding specifications. Such areas shall be maintained and guaranteed as stated above.

1.10 FINAL ACCEPTANCE

A. Lawn maintenance and guarantees by the Contractor shall cease upon receipt of written notice from the Owner's Authorized Representative indicating his final acceptance of the lawn and sprinkler irrigation system.

PART 2 - PRODUCTS

2.1 LOW WATER USE GRASS SOD

A. Low Water Use Grass Sod: shall be a "Bio Play" sod 60/40 blend with sand base, available through BioGrass Sod Farms, Sandy, Utah. (Phone Number: 801-562-9090) or approved equal. Submit supplier's certification and seed mix information for approval prior to delivery to the site.
   1. Only sod that has been grown on a commercial sod farm shall be used.
   2. Sod shall be of uniform density, color, and texture, strongly rooted, and capable of vigorous growth and development when planted.
   3. Superior sod grown from certified, high quality, seed of known origin or from plantings of certified grass seedlings or stolons.
   4. Assure over-all high quality and freedom from noxious weeds or an excessive amount of other crop and weedy plants at time of harvest.
   5. Sod shall be machine cut at a uniform soil thickness of three-quarters inch (3/4") at the time of cutting. Measurement for thickness shall exclude top growth and thatch. Individual pieces of sod shall be cut to the supplier's standard width and length. Maximum allowable deviation from standard widths and lengths shall be five percent 5%). Broken pads and torn or uneven ends will not be acceptable. Sod shall be at least one year old from time of original seeding.
   6. Sod shall be harvested, delivered and installed within a period of 24 hours. Soil on sod pads shall be kept moist at all times.
   7. Stakes: Stakes for pegging the sod shall be sound hardwood approximately one inch by two inches (1" x 2") and of sufficient length to penetrate the mat, the seed bed and to a minimum depth of two inches (2") of subsoil. Stakes shall be free from insects and fungi and capable of remaining in the ground at least two years.

2.2 FERTILIZER

A. Sustane 4-6-4 Natural Fertilizer mixture for first fertilizer application prior to sodding.

B. Commercial Fertilizer: Commercial-grade complete fertilizer, O-F-241C, type 1, grade 16-16-16, level B with guaranteed chemical analysis of contents marked on the containers.

2.3 MISCELLANEOUS PRODUCTS

A. Herbicide:

   1. Provide non-selective post emergent herbicide for use in weed control. Provide Round-up or approved equal.
   2. Provide pre-emergent herbicide for use in planter beds for weed control. Provide Treflan or approved equal.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protection

1. Take care in preparation work to avoid conditions which will create hazards. Post signs or barriers as required.
2. Provide adequate means for protection from damage through excessive erosion, flooding, heavy rains, etc. Repair or replace damaged areas.
3. Keep site well drained and landscape excavations dry.

B. Surface Preparation – Newly Graded Subgrades

1. Limit lawn subgrade preparation to areas to be planted.
2. Herbicide Treatment: All sod beds shall be weed free prior to commencing soil placement, fine grading, and planting. Treat areas with a non-selective herbicide as necessary to insure weed free planting areas. Herbicide applications shall be applied in accordance with manufacturer's recommendations and in accordance with section 3.4 Herbicide Application and Weed Control.
3. Provide erosion-control
4. Seven days maximum prior to sodding:
   a. Prepare subgrade and spread Planting Soil Mix in accordance to specification section 329119 – Fine Grading and Soil Preparation.
   b. Reduce elevation of planting soil to allow for soil thickness of sod.
5. After lawn areas have been prepared, take no heavy objects over them except lawn rollers.
6. After preparation of lawn areas and with topsoil in semi-dry condition, roll lawn planting areas in two directions at approximately right angles with water ballast roller weighing 100 to 300 lbs. according to soil type.
7. Rake or scarify and cut or fill irregularities that develop as required until area is true and uniform, free from lumps, depressions, and irregularities.

C. Surface Preparation – Unchanged Subgrades

1. Limit lawn subgrade preparation to areas to be planted.
2. Remove existing grass, vegetation, and turf. Do not mix into surface soil.
3. Loosen surface soil to a depth of at least 4 inches. Till soil to a homogeneous mixture of fine texture and break up all clods and lumps.
4. Remove stones larger than 3/4 inch in any dimension and clods, weeds, sticks, roots, and other extraneous matter and legally dispose them off of the Owner's property.

D. Finish Grading

1. Finish grades shall be in accordance with specification section 329119– Fine Grading and Soil Preparation. Adjustments of finish grades shall be made at the direction of the Landscape Architect as required. 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.

2. Moisten prepared lawn areas before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.
3. Restore areas if eroded or otherwise disturbed after finish grading and before planting.
4. Final grade of soil in all turf areas shall be as required to allow the finished grade of sod to be 1" below top of adjacent pavement.

3.2 INSTALLATION

A. Laying of Sod

1. Prior to laying sod, apply Sustane 4-6-fertilizer to the entire surface to receive sod at the rate of 4 pounds per 1,000 square feet.
2. Lay sod during growing season. Sodding during dry summer period, at freezing temperatures, or over frozen soil is not acceptable.
3. Lay sod within 24 hours of harvesting.
4. Lay sod to form a solid mass with tightly fitted joints, Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Cut out irregular or thin sections with a sharp knife. Avoid damage to subgrade or sod during installation. Tamp and roll lightly to ensure contact with subgrade, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.
5. Lay sod flush with adjoining existing sodded surfaces.
6. Lay sod at sloping areas with the long dimension of individual sod strips laid parallel with the contours of the slope.
7. Anchor sod on slopes exceeding 6:1 with wood pegs or steel staples spaced as recommended by sod manufacturer but not less than 2 anchors per sod strip to prevent slippage.
8. Do not sod slopes steeper than 3:1.

B. After Sodding Is Complete

1. Roll horizontal surface areas in two directions perpendicular to each other.
2. Repair and re-roll areas with depressions, lumps, or other irregularities. Heavy rolling to correct irregularities in grade will not be permitted.
3. Saturate sod with fine water spray within two hours of planting to obtain moisture penetration through sod into top 2" of topsoil.
4. During first two weeks, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 2 inches.
5. Fertilize every 21 days following initial application with a 16-16-16 fertilizer. Apply at a rate of one pound per 1,000 square feet of actual nitrogen, 4 percent phosphorus, and 2 percent potassium by weight using the same mix until maintenance period is over.

3.3 FIELD QUALITY CONTROL

A. Inspection

1. Sodded areas will be accepted at final inspection if -
   a. Sodded areas are properly established.
   b. Sod is healthy, well rooted, even-colored, free of bare and dead spots and without weeds.
   c. No surface soil is visible when grass has been cut to height of 2".
   d. Sodded areas have been mowed a minimum of twice.
2. Areas sodded after October 1 will be accepted the following spring (May 1st) approximately one month after start of growing season if specified conditions have been met.
3. Reestablish lawns that do not comply with requirements and continue maintenance at not additional cost to the owner until lawns are satisfactory.

3.4 HERBICIDE APPLICATION AND WEED CONTROL

A. Application of pre-emergent herbicide is required. The contractor shall maintain the sod weed free until the end of the establishment period.

B. Apply herbicides so no damage to protected vegetation occurs whether inside or outside the project site. Damage to protected vegetation or vegetation outside the project site will be reimbursed to the owner or replaced by the Contractor in a manner satisfactory to the Owner's Authorized Representative, and according to the International Society of Arboriculture Method of "Valuation for Landscape Trees, Shrubs, and Other Plants," latest edition.

C. Post Emergent Herbicide:

1. Mix and apply post-emergent herbicide according to manufacturer's recommendations indicated in the "Weeds Controlled" section of the label, and apply to undesired, actively growing vegetation.

2. Apply the spray mixture so that all undesired vegetation is uniformly covered, but avoid causing over-spray and drift. Spray target vegetation so that it is wet, but short of run-off.

3. Do not apply post-emergent herbicide in any of these conditions: When rainfall is expected within six hours; when there is growth stress as a result of drought, insects, disease, or plant damage, or when there is heavy dust on plants.

4. Do not walk or permit other traffic on treated areas when they are wet from application. Shoes and equipment may track spray solution to areas where vegetation is not to be treated.

5. Repeat application, as necessary to completely eradicate undesired vegetation.

D. Pre-emergent Herbicide:

1. Mix and apply pre-emergent herbicide according to manufacturer's recommendations and information on the side panel, and the following: Use granular applicators designed to apply herbicide at Manufacturer's suggested highest rate.

2. Calibrate the applicator according to the manufacturer's directions prior to use and check frequently during application to be sure the equipment is working properly and distributing the granules uniformly. Do not apply more than the recommended amount.

3. Apply granular herbicide according to manufacturer's recommendations and on site conditions and soil preparation requirements or restrictions appropriate to the herbicide used.

4. The pre-emergent application must be followed within 8 hours with overhead watering or rainfall equivalent to 1/2".

E. License: Use a state licensed applicator to apply herbicide.

F. Mechanical Control:

1. Mechanically control the weeds by pulling, cutting, hoeing, or by any other directed means approved by the Owner's Authorized Representative.

2. Weeds in a dormant stage or other condition which cannot be effectively controlled with post-emergent herbicide shall be removed from the site by mechanical methods.

3.5 SOD GUARANTEE

A. Protect, water, and replace any damaged sod until acceptance by Owner. Guarantee shall include filling any voids between sod pieces, repairing any eroded areas, and maintaining sod by watering, mowing, and controlling insects, fertilizing, as well as advising Owner of any maintenance or watering procedures necessary to care for and promote plant life. All sod must be in satisfactory condition at the time of the substantial completion inspection.

B. The contractor shall maintain the sprinkling system installed on the project and if there is an existing system he shall maintain it under the direct supervision of SUU Grounds.

3.6 CLEANING

A. Immediately clean up any soil or debris spilled onto pavement and dispose of all deleterious materials.

3.7 PROTECTION

A. Protect sodded areas against traffic or other use immediately after sodding is completed by placing adequate warning signs and barricades.

B. Provide adequate protection of sodded areas against trespassing, erosion, and damage of any kind. Remove this protection after sodded areas have been accepted by Landscape Architect.

END OF SECTION 329223

SECTION 330513 - MANHOLES AND STRUCTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Modular precast concrete manhole with tongue-and-groove joints, covers, anchorage, and accessories.
2. Bedding and cover materials.

B. Related Sections:
1. Section 312333 - Soil Materials: Backfill soil materials.
2. Section 330500 - Aggregate Materials: Aggregate for backfill in trenches.
3. Section 330500 - Backfilling for Pipelines and Structures.
4. Section 330500 - Trenching for Pipelines.

1.2 REFERENCES

A. American Concrete Institute:
1. ACI 318 - Building Code Requirements for Structural Concrete.
2. ACI 530/530.1 - Building Code Requirements for Masonry Structures and Specifications for Masonry Structures.

B. ASTM International:
1. ASTM A48/A48M - Standard Specification for Gray Iron Castings.
2. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
3. ASTM A536 - Standard Specification for Ductile Iron Castings.
4. ASTM C39/C39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
5. ASTM C55 - Standard Specification for Concrete Brick.
6. ASTM C62 - Standard Specification for Building Brick (Solid Masonry Units Made From Clay or Shale).
7. ASTM C478 - Standard Specification for Precast Reinforced Concrete Manhole Sections.
8. ASTM C497 - Standard Test Methods for Concrete Pipe, Manhole Sections, or Tile.
9. ASTM C913 - Standard Specification for Precast Concrete Water and Wastewater Structures.
10. ASTM C923 - Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals.
11. ASTM D3753 - Standard Specification for Glass-Fiber-Reinforced Polyester Manholes.

1.3 DESIGN REQUIREMENTS

A. Equivalent strength: Based on structural design of reinforced concrete as outlined in ACI 318.

B. Design of Lifting Devices for Precast Components: In accordance with ASTM C913.

C. Design of Joints for Precast Components: In accordance with ASTM C913; maximum leakage of 0.025 gallons per hour per foot of joint at 3 feet of head.

1.4 SUBMITTALS
A. Section 013300 - Submittal Procedures: Requirements for submittals.
B. Product Data: Submit cover and frame construction, features, configuration, dimensions.

1.5 QUALIFICATIONS
A. Manufacturer: Company specializing in manufacturing products specified in this Section with a minimum of three years experience.

1.6 DELIVERY, STORAGE AND HANDLING
A. Section 016000 - Product Requirements: Product storage and handling requirements.
B. Comply with precast concrete manufacturer's instructions for unloading, storing and moving precast manholes.
C. Store precast concrete manholes to prevent damage to Owner's property or other public or private property. Repair property damaged from materials storage.
D. Mark each precast structure by indentation or waterproof paint showing date of manufacture, manufacturer, and identifying symbols and numbers shown on Drawings to indicate its intended use.

PART 2 PRODUCTS

2.1 MANHOLES AND STRUCTURES
A. Manhole and Structure Sections: Reinforced precast concrete in accordance with ASTM C478 with gaskets in accordance with ASTM C923.

2.2 FRAMES AND COVERS
A. Manufacturers:
1. D & L Foundry Model A-1005
2. Barry Pattern and Foundry Co., Inc.
3. Campbell Foundry Co.
4. McKinley Iron Works
5. Neenah Foundry Co.
6. Substitutions: Section 016000 - Product Requirements Not Permitted.
B. Product Description: ASTM A48/A48M, Class 30B Cast iron construction, machined flat bearing surface, removable open checkerboard grille; cover molded with identifying name.

2.3 COMPONENTS
A. Manhole and Structure Steps: Formed rungs; 3/4 inch diameter.

2.4 CONFIGURATION
A. Shaft Construction: Concentric with eccentric flat top section; lipped male/female dry joints; sleeved to receive pipe conduit and sections.
B. Shape: Cylindrical.
C. Clear Inside Dimensions: As indicated on Drawings.
D. Design Depth: As indicated on Drawings.
E. Clear Cover Opening: 26 inches diameter. As indicated on Drawings.
F. Steps: 12 inches wide, 16 inches on center vertically, set into manhole and structure wall.

2.5 BEDDING AND COVER MATERIALS

A. Bedding: Fill Type A2 .
B. Cover: Fill Type A3,.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 013000 - Administrative Requirements: Verification of existing conditions before starting work.
B. Verify items provided by other sections of Work are properly sized and located.
C. Verify built-in items are in proper location, and ready for roughing into Work.
D. Verify correct size of manhole and structure excavation.

3.2 PREPARATION

A. Coordinate placement of inlet and outlet pipe or duct sleeves required by other sections.
B. Do not install structures where site conditions induce loads exceeding structural capacity of structures.
C. Inspect precast concrete structures immediately prior to placement in excavation to verify structures are internally clean and free from damage. Remove and replace damaged units.

3.3 INSTALLATION

A. Excavation and Backfill:
   1. Excavate for manholes and structures in accordance with Section 312316 in location and to depth shown. Provide clearance around sidewalls of structure for construction operations.
   2. When groundwater is encountered, prevent accumulation of water in excavations. Place manholes and structures in dry trench.
   3. Where possibility exists of watertight structure becoming buoyant in flooded excavation, anchor structure to avoid flotation.
B. Place base pad, trowel top surface level.
C. Place manhole and structure sections plumb and level, trim to correct elevations, anchor to base pad.

3.4 PRECAST CONCRETE MANHOLE AND STRUCTURE INSTALLATION

A. Lift precast components at lifting points designated by manufacturer.
B. When lowering manholes and structures into excavations and joining pipe to units, take precautions to ensure interior of pipeline and structure remains clean.
C. Set precast structures bearing firmly and fully on crushed stone bedding, compacted in accordance with provisions of Section 312323.23 or on other support system shown on Drawings.
D. Assemble multi-section structures by lowering each section into excavation. Lower, set level, and firmly position base section before placing additional sections.
E. Remove foreign materials from joint surfaces and verify sealing materials are placed properly. Maintain alignment between sections by using guide devices affixed to lower section.
F. Joint sealing materials may be installed on site or at manufacturer's plant.
G. Verify manholes and structures installed satisfy required alignment and grade.

H. Remove knockouts or cut structure to receive piping without creating openings larger than required to receive pipe. Fill annular space with mortar. Cut pipe to finish flush with interior of structure.
J. Shape inverts through manhole and structures as shown on Drawings.

3.5 FRAME AND COVER INSTALLATION
A. Set frame and cover 2 inches above finished grade for manholes and structures with covers located within unpaved areas to allow area to be graded away from cover beginning 1 inch below top surface of frame.

3.6 FIELD QUALITY CONTROL
A. Section 014000 - Quality Requirements 017000 - Execution Requirements: Field inspecting, testing, adjusting, and balancing.
B. Test cast-in-place concrete in accordance with Section 033000.

END OF SECTION

SECTION 331100 - WATER UTILITY DISTRIBUTION PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes water-distribution piping and related components outside the building for combined water service and fire-service mains.

B. Utility-furnished products include water meters that will be furnished to the site, ready for installation.

1.3 DEFINITIONS

A. EPDM: Ethylene propylene diene terpolymer rubber.

B. LLDPE: Linear, low-density polyethylene plastic.

C. PA: Polyamide (nylon) plastic.

D. PE: Polyethylene plastic.

E. PP: Polypropylene plastic.

F. PVC: Polyvinyl chloride plastic.

G. RTRF: Reinforced thermosetting resin (fiberglass) fittings.

H. RTRP: Reinforced thermosetting resin (fiberglass) pipe.

1.4 SUBMITTALS

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

B. Shop Drawings: Detail precast concrete vault assemblies and indicate dimensions, method of field assembly, and components.

1. Wiring Diagrams: Power, signal, and control wiring for alarms.

C. Coordination Drawings: For piping and specialties including relation to other services in same area, drawn to scale. Show piping and specialty sizes and valves, meter and specialty locations, and elevations.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For water valves and specialties to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Comply with requirements of utility company supplying water. Include tapping of water mains and backflow prevention.
2. Comply with standards of authorities having jurisdiction for potable-water-service piping, including materials, installation, testing, and disinfection.
3. Comply with standards of authorities having jurisdiction for fire-suppression water-service piping, including materials, hose threads, installation, and testing.

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

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with ASTM F 645 for selection, design, and installation of thermoplastic water piping.

E. Comply with FMG's "Approval Guide" or UL's "Fire Protection Equipment Directory" for fire-service-main products.

F. NFPA Compliance: Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire-service-main piping for fire suppression.

G. NSF Compliance:

1. Comply with NSF 14 for plastic potable-water-service piping. Include marking "NSF-pw" on piping.
2. Comply with NSF 61 for materials for water-service piping and specialties for domestic water.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Preparation for Transport: Prepare valves, including fire hydrants, according to the following:

1. Ensure that valves are dry and internally protected against rust and corrosion.

2. Protect valves against damage to threaded ends and flange faces.
3. Set valves in best position for handling. Set valves closed to prevent rattling.

B. During Storage: Use precautions for valves, including fire hydrants, according to the following:

1. Do not remove end protectors unless necessary for inspection; then reinstall for storage.
2. Protect from weather. Store indoors and maintain temperature higher than ambient dew-point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.

C. Handling: Use sling to handle valves and fire hydrants if size requires handling by crane or lift. Rig valves to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

D. Deliver piping 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.

E. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.

F. Protect flanges, fittings, and specialties from moisture and dirt.

G. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

1.7 PROJECT CONDITIONS

A. Interruption of Existing Water-Distribution 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 water-distribution service according to requirements indicated:

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

1.8 COORDINATION

A. Coordinate connection to water main with Southern Utah University Facilities Management.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Soft Copper Tube: ASTM B 88, Type K water tube, annealed temper.

1. Copper, Solder-Joint Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint pressure type. Furnish only wrought-copper fittings if indicated.
2. Copper, Pressure-Seal Fittings:

    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) Viega; Plumbing & Heating Systems.

    c. NPS 2 and Smaller: Wrought-copper fitting with EPDM O-ring seal in each end.
    d. NPS 2-1/2 to NPS 4 :Bronze fitting with stainless-steel grip ring and EPDM O-ring seal in each end.

B. Hard Copper Tube: ASTM B 88, Type K, water tube, drawn temper.

1. Copper, Solder-Joint Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint pressure type. Furnish only wrought-copper fittings if indicated.
2. Copper, Pressure-Seal Fittings:

    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) Viega; Plumbing & Heating Systems.

    c. NPS 2 and Smaller: Wrought-copper fitting with EPDM O-ring seal in each end.
    d. NPS 2-1/2 to NPS 4 : Bronze fitting with stainless-steel grip ring and EPDM O-ring seal in each end.

C. Bronze Flanges: ASME B16.24, Class 150, with solder-joint end. Furnish Class 300 flanges if required to match piping.

D. 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.

2.2 DUCTILE-IRON PIPE AND FITTINGS

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

1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
2. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.

1. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
2. Gaskets: AWWA C111, rubber.

C. Grooved-Joint, Ductile-Iron Pipe: AWWA C151, with cut, rounded-grooved ends.

1. Grooved-End, Ductile-Iron Pipe Appurtenances:

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) Anvil International, Inc.
2) Victaulic Company of America.

c. Grooved-End, Ductile-Iron Fittings: ASTM A 47/A 47M, malleable-iron castings or ASTM A 536, ductile-iron castings with dimensions matching pipe.
d. Grooved-End, Ductile-Iron-Piping Couplings: AWWA C606, for ductile-iron-pipe dimensions. Include ferrous housing sections, gasket suitable for water, and bolts and nuts.

D. Flanges: ASME 16.1, Class 125, cast iron.

2.3 PE PIPE AND FITTINGS

A. PE, ASTM Pipe: ASTM D 2239, SIDR No. 5.3, 7, or 9; with PE compound number required to give pressure rating not less than 200 psig.

1. Insert Fittings for PE Pipe: ASTM D 2609, made of PA, PP, or PVC with serrated male insert ends matching inside of pipe. Include bands or crimp rings.
2. Molded PE Fittings: ASTM D 3350, PE resin, socket- or butt-fusion type, made to match PE pipe dimensions and class.

B. PE, AWWA Pipe: AWWA C906, DR No. 7.3, 9, or 9.3; with PE compound number required to give pressure rating not less than 200 psig.

1. PE, AWWA Fittings: AWWA C906, socket- or butt-fusion type, with DR number matching pipe and PE compound number required to give pressure rating not less than 200 psig.

C. PE, Fire-Service Pipe: ASTM F 714, AWWA C906, or equivalent for PE water pipe; FMG approved, with minimum thickness equivalent to FMG Class 150.

1. Molded PE Fittings: ASTM D 3350, PE resin, socket- or butt-fusion type, made to match PE pipe dimensions and class.

2.4 PVC PIPE AND FITTINGS

A. PVC, Schedule 40 Pipe: ASTM D 1785.

1. PVC, Schedule 40 Socket Fittings: ASTM D 2466.

B. PVC, Schedule 80 Pipe: ASTM D 1785.

1. PVC, Schedule 80 Socket Fittings: ASTM D 2467.
2. PVC, Schedule 80 Threaded Fittings: ASTM D 2464.

C. PVC, AWWA Pipe: AWWA C900, Class 150, with bell end with gasket, and with spigot end.

1. Comply with UL 1285 for fire-service mains if indicated.
PVC Fabricated Fittings: AWWA C900, Class 150, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.
2. PVC Molded Fittings: AWWA C907, Class 150, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.
3. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.

a. Gaskets: AWWA C111, rubber.

4. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.

a. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

2.5 SPECIAL PIPE FITTINGS

A. Ductile-Iron Rigid Expansion Joints:

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

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

   a. EBAA Iron, Inc.
   b. U.S. Pipe and Foundry Company.

3. Description: Three-piece, ductile-iron assembly consisting of telescoping sleeve with gaskets and restrained-type, ductile-iron, bell-and-spigot end sections complying with AWWA C110 or AWWA C153. Select and assemble components for expansion indicated. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.

   a. Pressure Rating: 250 psig minimum.

B. Ductile-Iron Flexible Expansion Joints:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. EBAA Iron, Inc.
   b. Hays Fluid Controls; a division of ROMAC Industries Inc.
   c. Star Pipe Products.

3. Description: Compound, ductile-iron fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include two gasketed ball-joint sections and one or more gasketed sleeve sections. Assemble components for offset and expansion indicated. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.

   a. Pressure Rating: 250 psig minimum.
   b.

C. Ductile-Iron Deflection 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:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. EBAA Iron, Inc.

3. Description: Compound, ductile-iron coupling fitting with sleeve and 1 or 2 flexing sections for up to 15-degree deflection, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.

a. Pressure Rating: 250 psig minimum.

2.6 JOINING MATERIALS

A. Refer to Division 2 Section "Piped Utilities - Basic Materials and Methods" for commonly used joining materials.

B. Brazing Filler Metals: AWS A5.8, BCuP Series.

C. Bonding Adhesive for Fiberglass Piping: As recommended by fiberglass piping manufacturer.

D. Plastic Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

2.7 PIPING SPECIALTIES

A. Transition Fittings: Manufactured fitting or coupling same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

B. Tubular-Sleeve Pipe 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:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Cascade Waterworks Manufacturing.
   b. Dresser, Inc.; Dresser Piping Specialties.
   c. Ford Meter Box Company, Inc. (The); Pipe Products Div.
   d. Hays Fluid Controls; a division of ROMAC Industries Inc.
   e. JCM Industries.
   f. Smith-Blair, Inc.
   g. Viking Johnson.

3. Description: Metal, bolted, sleeve-type, reducing or transition coupling, with center sleeve, gaskets, end rings, and bolt fasteners and with ends of same sizes as piping to be joined.

   a. Standard: AWWA C219.
   b. Center-Sleeve Material: Manufacturer's standard.
   c. Gasket Material: Natural or synthetic rubber.
   d. Pressure Rating: 150 psig minimum.
   e. Metal Component Finish: Corrosion-resistant coating or material.

C. Split-Sleeve Pipe 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:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Victaulic Depend-O-Lok.

3. Description: Metal, bolted, split-sleeve-type, reducing or transition coupling with sealing pad and closure plates, O-ring gaskets, and bolt fasteners.

    a. Standard: AWWA C219.
    b. Sleeve Material: Manufacturer's standard.
    c. Sleeve Dimensions: Of thickness and width required to provide pressure rating.
    d. Gasket Material: O-rings made of EPDM rubber, unless otherwise indicated.
    e. Pressure Rating: 150 psig minimum.
    f. Metal Component Finish: Corrosion-resistant coating or material.

D. Flexible Connectors:

1. Nonferrous-Metal Piping: Bronze hose covered with bronze wire braid; with copper-tube, pressure-type, solder-joint ends or bronze flanged ends brazed to hose.
2. Ferrous-Metal Piping: Stainless-steel hose covered with stainless-steel wire braid; with ASME B1.20.1, threaded steel pipe nipples or ASME B16.5, steel pipe flanges welded to hose.

E. Dielectric Fittings: Combination of copper alloy and ferrous; threaded, solder, or plain end types; and matching piping system materials.

1. Dielectric Unions: Factory-fabricated union assembly, designed for 250-psig minimum working pressure at 180 deg F. Include insulating material that isolates dissimilar metals and ends with inside threads according to ASME B1.20.1.
2. Dielectric Flanges: Factory-fabricated companion-flange assembly, for 150- or 300-psig minimum working pressure to suit system pressures.
3. Dielectric-Flange Insulation Kits: Field-assembled companion-flange assembly, full-face or ring type. Components include neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

    a. Provide separate companion flanges and steel bolts and nuts for 150- or 300-psig (minimum working pressure to suit system pressures.

4. Dielectric Couplings: Galvanized-steel couplings with inert and noncorrosive thermoplastic lining, with threaded ends and 300-psig minimum working pressure at 225 deg F.
5. Dielectric Nipples: Electroplated steel nipples with inert and noncorrosive thermoplastic lining, with combination of plain, threaded, or grooved end types, and 300-psig minimum working pressure at 225 deg F.

2.8 GATE VALVES

A. AWWA, Cast-Iron Gate 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:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

   a. American AVK Co.; Valves & Fittings Div.
   b. American Cast Iron Pipe Co.; American Flow Control Div.
   c. American Cast Iron Pipe Co.; Waterous Co. Subsidiary.
   d. Crane Co.; Crane Valve Group; Stockham Div.
   e. East Jordan Iron Works, Inc.
   f. McWane, Inc.; Clow Valve Co. Div. (Oskaloosa).
   g. McWane, Inc.; Kennedy Valve Div.
   h. McWane, Inc.; M & H Valve Company Div.
   i. McWane, Inc.; Tyler Pipe Div.; Utilities Div.
   j. Mueller Co.; Water Products Div.
   k. NIBCO INC.
   l. U.S. Pipe and Foundry Company.

4. Nonrising-Stem, Metal-Seated Gate Valves:

   a. Description: Gray- or ductile-iron body and bonnet; with cast-iron or bronze double-disc gate, bronze gate rings, bronze stem, and stem nut.

      1) Standard: AWWA C500.
      2) Minimum Pressure Rating: 200 psig.
      3) End Connections: Mechanical joint.
      4) Interior Coating: Complying with AWWA C550.

5. Nonrising-Stem, Resilient-Seated Gate Valves:

   a. Description: Gray- or ductile-iron body and bonnet; with bronze or gray- or ductile-iron gate, resilient seats, bronze stem, and stem nut.

      1) Standard: AWWA C509.
      2) Minimum Pressure Rating: 200 psig.
      3) End Connections: Mechanical joint.
      4) Interior Coating: Complying with AWWA C550.

6. Nonrising-Stem, High-Pressure, Resilient-Seated Gate Valves:

a. Description: Ductile-iron body and bonnet; with bronze or ductile-iron gate, resilient seats, bronze stem, and stem nut.

1) Standard: AWWA C509.
2) Minimum Pressure Rating: 250 psig.
3) End Connections: Push on or mechanical joint.
4) Interior Coating: Complying with AWWA C550.

7. OS&Y, Rising-Stem, Metal-Seated Gate Valves:

a. Description: Cast- or ductile-iron body and bonnet, with cast-iron double disc, bronze disc and seat rings, and bronze stem.

1) Standard: AWWA C500.
2) Minimum Pressure Rating: 200 psig.
3) End Connections: Flanged.

8. OS&Y, Rising-Stem, Resilient-Seated Gate Valves:

a. Description: Cast- or ductile-iron body and bonnet, with bronze or gray- or ductile-iron gate, resilient seats, and bronze stem.

1) Standard: AWWA C509.
2) Minimum Pressure Rating: 200 psig.
3) End Connections: Flanged.

B. UL/FMG, Cast-Iron Gate 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:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

a. American Cast Iron Pipe Co.; American Flow Control Div.
b. American Cast Iron Pipe Co.; Waterous Co. Subsidiary.
c. Crane Co.; Crane Valve Group; Stockham Div.
d. McWane, Inc.; Clow Valve Co. Div. (Oskaloosa).
e. McWane, Inc.; Kennedy Valve Div.
f. McWane, Inc.; M & H Valve Company Div.
g. Mueller Co.; Water Products Div.
h. NIBCO INC.
i. U.S. Pipe and Foundry Company.

4. UL/FMG, Nonrising-Stem Gate Valves:

a. Description: Iron body and bonnet with flange for indicator post, bronze seating material, and inside screw.

1) Standards: UL 262 and FMG approved.
2) Minimum Pressure Rating: 175 psig.
3) End Connections: Flanged.

5. OS&Y, Rising-Stem Gate Valves:

a. Description: Iron body and bonnet and bronze seating material.

1) Standards: UL 262 and FMG approved.
2) Minimum Pressure Rating: 175 psig .
3) End Connections: Flanged.

C. Bronze Gate 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:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of 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 Div.
d. Hammond Valve.
e. Milwaukee Valve Company.
f. NIBCO INC.
g. Red-White Valve Corporation.

4. OS&Y, Rising-Stem Gate Valves:

a. Description: Bronze body and bonnet and bronze stem.

1) Standards: UL 262 and FMG approved.
2) Minimum Pressure Rating: 175 psig.
3) End Connections: Threaded.

5. Nonrising-Stem Gate Valves:

a. Description: Class 125, Type 1, bronze with solid wedge, threaded ends, and malleable-iron handwheel.

1) Standard: MSS SP-80.

2.9 GATE VALVE ACCESSORIES AND SPECIALTIES

A. Tapping-Sleeve Assemblies:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

    a. American Cast Iron Pipe Co.; Waterous Co. Subsidiary.
    b. East Jordan Iron Works, Inc.
    c. Flowserve.
    d. McWane, Inc.; Clow Valve Co. Div. (Oskaloosa).
    e. McWane, Inc.; Kennedy Valve Div.
    f. McWane, Inc.; M & H Valve Company Div.
    g. Mueller Co.; Water Products Div.
    h. U.S. Pipe and Foundry Company.

4. Description: Sleeve and valve compatible with drilling machine.

    a. Standard: MSS SP-60.
    b. Tapping Sleeve: Cast- or ductile-iron or stainless-steel, two-piece bolted sleeve with flanged outlet for new branch connection. Include sleeve matching size and type of pipe material being tapped and with recessed flange for branch valve.
    c. Valve: AWWA, cast-iron, nonrising-stem, resilient-seated gate valve with one raised face flange mating tapping-sleeve flange.

B. Valve Boxes: Comply with AWWA M44 for cast-iron valve boxes. Include top section, adjustable extension of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over valve and with a barrel approximately 5 inches in diameter.

1. Operating Wrenches: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut.

C. Indicator Posts: UL 789, FMG-approved, vertical-type, cast-iron body with operating wrench, extension rod, and adjustable cast-iron barrel of length required for depth of burial of valve.

2.10 CHECK VALVES

A. AWWA Check 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:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

    a. American AVK Co.; Valves & Fittings Div.
    b. American Cast Iron Pipe Co.; American Flow Control Div.
    c. APCO Williamette; Valve and Primer Corporation.
    d. Crane Co.; Crane Valve Group; Crane Valves.
    e. Crane Co.; Crane Valve Group; Stockham Div.
    f. McWane, Inc.; Clow Valve Co. Div. (Oskaloosa).
    g. McWane, Inc.; Kennedy Valve Div.
    h. McWane, Inc.; M & H Valve Company Div.
    i. Mueller Co.; Water Products Div.
    j. NIBCO INC.
    k. Watts Water Technologies, Inc.

4. Description: Swing-check type with resilient seat. Include interior coating according to AWWA C550 and ends to match piping.

    a. Standard: AWWA C508.
    b. Pressure Rating: 175 psig .

B. UL/FMG, Check 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:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

    a. American Cast Iron Pipe Co.; Waterous Co. Subsidiary.
    b. Crane Co.; Crane Valve Group; Stockham Div.
    c. Globe Fire Sprinkler Corporation.
    d. Kidde Fire Fighting.
    e. MATCO-NORCA, Inc.
    f. McWane, Inc.; Clow Valve Co. Div. (Oskaloosa).
    g. McWane, Inc.; Kennedy Valve Div.
    h. Mueller Co.; Water Products Div.
    i. NIBCO INC.
    j. Reliable Automatic Sprinkler Co., Inc.
    k. Tyco Fire & Building Products.
    l. United Brass Works, Inc.

m. Victaulic Company of America.
n. Viking Corporation.
o. Watts Water Technologies, Inc.

4. Description: Swing-check type with pressure rating; rubber-face checks, unless otherwise indicated; and ends matching piping.

a. Standards: UL 312 and FMG approved.
b. Pressure Rating: 175 psig.

2.11 DETECTOR CHECK VALVES

A. Detector Check 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:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

a. Ames Fire & Waterworks; a division of Watts Regulator Co.
b. Badger Meter, Inc.
c. FEBCO; SPX Valves & Controls.
d. Globe Fire Sprinkler Corporation.
e. McWane, Inc.; Kennedy Valve Div.
f. Mueller Co.; Hersey Meters.
g. Victaulic Company of America.
h. Viking Corporation.
i. Watts Water Technologies, Inc.

4. Description: Galvanized cast-iron body, bolted cover with air-bleed device for access to internal parts, and flanged ends. Include one-piece bronze disc with bronze bushings, pivot, and replaceable seat. Include threaded bypass taps in inlet and outlet for bypass meter connection. Set valve to allow minimal water flow through bypass meter when major water flow is required.

a. Standards: UL 312 and FMG approved.
b. Pressure Rating: 175 psig.
c. Water Meter: AWWA C700, disc type, at least one-fourth size of detector check valve. Include meter, bypass piping, gate valves, check valve, and connections to detector check valve.

5. Description: Iron body, corrosion-resistant clapper ring and seat ring material, flanged ends, with connections for bypass and installation of water meter.

a. Standards: UL 312 and FMG approved.
b. Pressure Rating: 175 psig.

2.12 BUTTERFLY VALVES

A. AWWA Butterfly 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:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

a. DeZURIK/Copes-Vulcan; a unit of SPX Corporation.
b. Milliken Valve Company.
c. Mosser Valve; a division of Olson Technologies, Inc.
d. Mueller Co.; Water Products Div.
e. Pratt, Henry Company.
f. Val-Matic Valve & Manufacturing Corp.

4. Description: Rubber seated.

a. Standard: AWWA C504.
b. Body: Cast or ductile iron.
c. Body Type: Flanged.
d. Pressure Rating: 150 psig.

B. UL Butterfly 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:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

a. McWane, Inc.; Kennedy Valve Div.
b. Milwaukee Valve Company.
c. Mueller Co.; Water Products Div.
d. NIBCO INC.
e. Pratt, Henry Company.

4. Description: Metal on resilient material seating.

a. Standards: UL 1091 and FMG approved.
b. Body: Cast or ductile iron.
c. Body Type: Flanged.
d. Pressure Rating: 175 psig.

2.13 PLUG VALVES

A. Plug 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:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

   a. DeZURIK/Copes-Vulcan; a unit of SPX Corporation.
   b. Homestead Valve; a division of Olson Technologies, Inc.
   c. Milliken Valve Company.
   d. McWane, Inc.; M & H Valve Company Div.
   e. Pratt, Henry Company.
   f. Val-Matic Valve & Manufacturing Corp.

4. Description: Resilient-seated eccentric.

   a. Standard: MSS SP-108.
   b. Body: Cast iron.
   c. Pressure Rating: 175-psig minimum CWP.
   d. Seat Material: Suitable for potable-water service.

2.14 PRESSURE-REDUCING VALVES

A. Water Regulators:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

   a. Cash Acme; a division of The Reliance Worldwide Corporation.
   b. Conbraco Industries, Inc.
   c. Honeywell Water Controls.

d. Watts Water Technologies, Inc.
e. Zurn Plumbing Products Group; Wilkins Water Control Products Div.

4. Standard: ASSE 1003.
5. Pressure Rating: Initial pressure of 150 psig.

B. Water Control 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:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

a. CLA-VAL Automatic Control Valves.
b. Flomatic Corporation.
c. OCV Control Valves.
d. Watts Regulator Co.; Ames Fluid Control Systems.
e. Watts Regulator Co.; Watts ACV Division.
f. Zurn Plumbing Products Group; Wilkins Water Control Products Div.

4. Description: Pilot-operation, diaphragm-type, single-seated main water control valve with AWWA C550 or FDA-approved, interior epoxy coating. Include small pilot control valve, restrictor device, specialty fittings, and sensor piping.

a. Pressure Rating: Initial pressure of 150 psig minimum.
b. Main Valve Body: Cast- or ductile-iron body with AWWA C550 or FDA-approved, interior epoxy coating; or stainless-steel body.

2.15 RELIEF VALVES

A. Air-Release 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:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

a. Crispin-Multiplex Manufacturing Co.
b. GA Industries, Inc.

c. Val-Matic Valve & Manufacturing Corp.

4. Description: Hydromechanical device to automatically release accumulated air.

a. Standard: AWWA C512.
b. Pressure Rating: 300 psig .
c. Body Material: Cast iron.
d. Trim Material: Stainless steel

B. Air/Vacuum 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:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

a. Crispin-Multiplex Manufacturing Co.
b. GA Industries, Inc.
c. Val-Matic Valve & Manufacturing Corp.

4. Description: Direct-acting, float-operated, hydromechanical device with large orifice to automatically release accumulated air or to admit air during filling of piping.

a. Standard: AWWA C512.
b. Pressure Rating: 300 psig.
c. Body Material: Cast iron.
d. Trim Material: Stainless steel.

C. Combination Air 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:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

a. Crispin-Multiplex Manufacturing Co.
b. GA Industries, Inc.
c. Val-Matic Valve & Manufacturing Corp.

4. Description: Float-operated, hydromechanical device to automatically release accumulated air or to admit air.

a. Standard: AWWA C512.
b. Pressure Rating: 300 psig.
c. Body Material: Cast iron.
d. Trim Material: Stainless steel.

2.16 VACUUM BREAKERS

A. Pressure Vacuum Breaker Assembly:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

   a. Ames Fire & Waterworks; a division of Watts Regulator Co.
   b. Conbraco Industries, Inc.
   c. FEBCO; SPX Valves & Controls.
   d. Flomatic Corporation.
   e. Toro Co. (The); Irrigation Division.
   f. Watts Water Technologies, Inc.
   g. Zurn Plumbing Products Group; Wilkins Water Control Products Div.

4. Standard: ASSE 1020.
5. Operation: Continuous-pressure applications.
6. Pressure Loss: 5 psig maximum, through middle 1/3 of flow range.
7. Accessories: Ball valves on inlet and outlet.

2.17 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

   a. Ames Fire & Waterworks; a division of Watts Regulator Co.
   b. Conbraco Industries, Inc.
   c. FEBCO; SPX Valves & Controls.
   d. Flomatic Corporation.

e. Watts Water Technologies, Inc.
f. Zurn Plumbing Products Group; Wilkins Water Control Products Div.

4. Standard: AWWA C511.
5. Operation: Continuous-pressure applications.
6. Pressure Loss: 12 psig maximum, through middle 1/3 of flow range.

B. Double-Check, Backflow-Prevention Assemblies:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

a. Ames Fire & Waterworks; a division of Watts Regulator Co.
b. Conbraco Industries, Inc.
c. FEBCO; SPX Valves & Controls.
d. Flomatic Corporation.
e. Watts Water Technologies, Inc.
f. Zurn Plumbing Products Group; Wilkins Water Control Products Div.

4. Standard: AWWA C510.
5. Operation: Continuous-pressure applications, unless otherwise indicated.
6. Pressure Loss: 5 psig maximum, through middle 1/3 of flow range.

C. Reduced-Pressure-Detector, Fire-Protection Backflow Preventer Assemblies:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

a. Ames Fire & Waterworks; a division of Watts Regulator Co.
b. Conbraco Industries, Inc.
c. FEBCO; SPX Valves & Controls.
d. Watts Water Technologies, Inc.
e. Zurn Plumbing Products Group; Wilkins Water Control Products Div.

4. Standards: ASSE 1047 and UL listed or FMG approved.
5. Operation: Continuous-pressure applications.
6. Pressure Loss: 12 psig maximum, through middle 1/3 of flow range.
7. Accessories:

a. Valves: UL 262, FMG-approved, OS&Y gate type with flanged ends on inlet and outlet.
b. Air-Gap Fitting: ASME A112.1.2, matching backflow preventer connection.
c. Bypass: With displacement-type water meter, shutoff valves, and reduced-pressure backflow preventer.

D. Double-Check, Detector-Assembly Backflow Preventers:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

a. Ames Fire & Waterworks; a division of Watts Regulator Co.
b. Conbraco Industries, Inc.
c. FEBCO; SPX Valves & Controls.
d. Watts Water Technologies, Inc.
e. Zurn Plumbing Products Group; Wilkins Water Control Products Div.

4. Standards: ASSE 1048 and UL listed or FMG approved.
5. Operation: Continuous-pressure applications.
6. Pressure Loss: 5 psig maximum, through middle 1/3 of flow range.
7. Accessories:

a. Valves: UL 262, FMG-approved, OS&Y gate type with flanged ends on inlet and outlet.
b. Bypass: With displacement-type water meter, shutoff valves, and reduced-pressure backflow preventer.

E. Backflow Preventer Test 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:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

a. Conbraco Industries, Inc.
b. FEBCO; SPX Valves & Controls.
c. Flomatic Corporation.
d. Watts Water Technologies, Inc.
e. Zurn Plumbing Products Group; Wilkins Water Control Products Div.

4. Description: Factory calibrated, with gages, fittings, hoses, and carrying case with test-procedure instructions.

2.18 FIRE HYDRANTS

A. Dry-Barrel Fire Hydrants:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

    a. American AVK Co.; Valves & Fittings Div.
    b. American Cast Iron Pipe Co.; American Flow Control Div.
    c. American Cast Iron Pipe Co.; Waterous Co. Subsidiary.
    d. American Foundry Group, Inc.
    e. East Jordan Iron Works, Inc.
    f. McWane, Inc.; Clow Valve Co. Div. (Oskaloosa).
    g. McWane, Inc.; Kennedy Valve Div.
    h. McWane, Inc.; M & H Valve Company Div.
    i. Mueller Co.; Water Products Div.
    j. Troy Valve; a division of Penn-Troy Manufacturing, Inc.
    k. U.S. Pipe and Foundry Company.

4. Description: Freestanding, with one NPS 4-1/2 and two NPS 2-1/2 outlets, 5-1/4-inch main valve, drain valve, and NPS 6 mechanical-joint inlet. Include interior coating according to AWWA C550. Hydrant shall have cast-iron body, compression-type valve opening against pressure and closing with pressure.

    a. Standard: AWWA C502.
    b. Pressure Rating: 150 psig minimum.

5. Description: Freestanding, with one NPS 4-1/2 and two NPS 2-1/2 outlets, 5-1/4-inch main valve, drain valve, and NPS 6 mechanical-joint inlet. Hydrant shall have cast-iron body, compression-type valve opening against pressure and closing with pressure.

    a. Standards: UL 246, FMG approved.
    b. Pressure Rating: 150 psig minimum.
    c. Outlet Threads: NFPA 1963, with external hose thread used by local fire department. Include cast-iron caps with steel chains.
    d. Operating and Cap Nuts: Pentagon, 1-1/2 inches point to flat.
    e. Direction of Opening: Open hydrant valve by turning operating nut to left or counterclockwise.
    f. Exterior Finish: Red alkyd-gloss enamel paint, unless otherwise indicated.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Refer to Division 2 Section "Earthwork" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

A. General: Use pipe, fittings, and joining methods for piping systems according to the following applications.

B. Transition couplings and special fittings with pressure ratings at least equal to piping pressure rating may be used, unless otherwise indicated.

C. Do not use flanges or unions for underground piping.

D. Flanges, unions, grooved-end-pipe couplings, and special fittings may be used, instead of joints indicated, on aboveground piping and piping in vaults.

E. Underground water-service piping NPS 3/4 to NPS 3 shall be the following:

1. Soft copper tube, ASTM B 88, Type wrought-copper, solder-joint fittings; and brazed joints.

F. Underground water and fire-service piping NPS 4 to NPS 8 shall be the following:
1. Ductile-iron, push-on-joint pipe; and gasketed mechanical-joint pipe; ductile-iron, mechanical-joint fittings; joints.

3.3 VALVE APPLICATIONS

A. General Application: Use mechanical-joint-end valves for NPS 3 and larger underground installation. Use threaded- or flanged-end valves for installation in vaults. Use UL/FMG, nonrising-stem gate valves for installation with indicator posts. Use corporation valves and curb valves with ends compatible with piping, for NPS 2 and smaller installation.

B. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Underground Valves, NPS 3 and Larger: AWWA, cast-iron, nonrising-stem, resilient-seated gate valves with valve box.
2. Underground Valves, NPS 4 and Larger, for Indicator Posts: UL/FMG, cast-iron, nonrising-stem gate valves with indicator post.
3. Use the following for valves in vaults and aboveground:

a. Gate Valves, NPS 2 and Smaller: Bronze, nonrising stem.

b. Gate Valves, NPS 3 and Larger: AWWA, cast iron,
c. Check Valves: AWWA C508, swing type.

4. Pressure-Reducing Valves: Use for water-service piping in vaults and aboveground to control water pressure.
5. Relief Valves: Use for water-service piping in vaults and aboveground.

   a. Air-Release Valves: To release accumulated air.
   b. Air/Vacuum Valves: To release or admit large volume of air during filling of piping.
   c. Combination Air Valves: To release or admit air.

6. Detector Check Valves: Use for water-service piping in vaults and aboveground to detect unauthorized use of water.

3.4 PIPING SYSTEMS - COMMON REQUIREMENTS

A. See Division 2 Section "Piped Utilities - Basic Materials and Methods" for piping-system common requirements.

3.5 PIPING INSTALLATION

A. Water-Main Connection: Arrange with utility company for tap of size and in location indicated in water main.

B. Water-Main Connection: Tap water main according to requirements of water utility company and of size and in location indicated.

C. Make connections larger than NPS 2 with tapping machine according to the following:

1. Install tapping sleeve and tapping valve according to MSS SP-60.
2. Install tapping sleeve on pipe to be tapped. Position flanged outlet for gate valve.
3. Use tapping machine compatible with valve and tapping sleeve; cut hole in main. Remove tapping machine and connect water-service piping.
4. Install gate valve onto tapping sleeve. Comply with MSS SP-60. Install valve with stem pointing up and with valve box.

D. Make connections NPS 2 and smaller with drilling machine according to the following:

1. Install service-saddle assemblies and corporation valves in size, quantity, and arrangement required by utility company standards.
2. Install service-saddle assemblies on water-service pipe to be tapped. Position outlets for corporation valves.
3. Use drilling machine compatible with service-saddle assemblies and corporation valves. Drill hole in main. Remove drilling machine and connect water-service piping.
4. Install corporation valves into service-saddle assemblies.

5. Install manifold for multiple taps in water main.
6. Install curb valve in water-service piping with head pointing up and with service box.

E. Comply with NFPA 24 for fire-service-main piping materials and installation.

1. Install PE corrosion-protection encasement according to ASTM A 674 or AWWA C105.
2. Install copper tube and fittings according to CDA's "Copper Tube Handbook."

F. Install ductile-iron, water-service piping according to AWWA C600 and AWWA M41.

1. Install PE corrosion-protection encasement according to ASTM A 674 or AWWA C105.

G. Install PVC, AWWA pipe according to ASTM F 645 and AWWA M23.

H. Bury piping with depth of cover over top at least 36 inches.

I. Install piping by tunneling or jacking, or combination of both, under streets and other obstructions that cannot be disturbed.

J. Extend water-service piping and connect to water-supply source and building-water-piping systems at outside face of building wall in locations and pipe sizes indicated.

1. Terminate water-service piping at 5’ outside of building wall until building-water-piping systems are installed. Terminate piping with caps, plugs, or flanges as required for piping material. Make connections to building-water-piping systems when those systems are installed.

K. Mechanical sleeve seals are specified in Division 15 Section "Basic Mechanical Materials and Methods."

L. Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports.

M. See Division 13 Section "Fire-Suppression Piping" for fire-suppression-water piping inside the building.

N. See Division 15 Section "Domestic Water Piping" for potable-water piping inside the building.

3.6 JOINT CONSTRUCTION

A. See Division 2 Section "Piped Utilities - Basic Materials and Methods" for basic piping joint construction.

B. Make pipe joints according to the following:

1. Copper-Tubing, Pressure-Sealed Joints: Use proprietary crimping tool and procedure recommended by copper, pressure-seal-fitting manufacturer.

2. Ductile-Iron Piping, Gasketed Joints for Water-Service Piping: AWWA C600 and AWWA M41.
3. Ductile-Iron Piping, Gasketed Joints for Fire-Service-Main Piping: UL 194.
4. Ductile-Iron Piping, Grooved Joints: Cut-groove pipe. Assemble joints with grooved-end, ductile-iron-piping couplings, gaskets, lubricant, and bolts according to coupling manufacturer's written instructions.
5. PE Piping Insert-Fitting Joints: Use plastic insert fittings and fasteners according to fitting manufacturer's written instructions.
6. PVC Piping Gasketed Joints: Use joining materials according to AWWA C900. Construct joints with elastomeric seals and lubricant according to ASTM D 2774 or ASTM D 3139 and pipe manufacturer's written instructions.
7. Fiberglass Piping Bonded Joints: Use adhesive and procedure recommended by piping manufacturer.
8. Dissimilar Materials Piping Joints: Use adapters compatible with both piping materials, with OD, and with system working pressure. Refer to Division 2 Section "Piped Utilities - Basic Materials and Methods" for joining piping of dissimilar metals.

3.7 ANCHORAGE INSTALLATION

A. Anchorage, General: Install water-distribution piping with restrained joints. Anchorages and restrained-joint types that may be used include the following:

1. Concrete thrust blocks.
2. Locking mechanical joints.
3. Set-screw mechanical retainer glands.
4. Bolted flanged joints.
5. Heat-fused joints.
6. Pipe clamps and tie rods.

B. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches. Include anchorages for the following piping systems:

1. Gasketed-Joint, Ductile-Iron, Water-Service Piping: According to AWWA C600.
2. Gasketed-Joint, PVC Water-Service Piping: According to AWWA M23.
3. Bonded-Joint Fiberglass, Water-Service Piping: According to AWWA M45.
4. Fire-Service-Main Piping: According to NFPA 24.

C. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

3.8 VALVE INSTALLATION

A. AWWA Gate Valves: Comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box.

B. AWWA Valves Other Than Gate Valves: Comply with AWWA C600 and AWWA M44.

C. UL/FMG, Gate Valves: Comply with NFPA 24. Install each underground valve and valves in vaults with stem pointing up and with vertical cast-iron indicator post.

D. UL/FMG, Valves Other Than Gate Valves: Comply with NFPA 24.

E. MSS Valves: Install as component of connected piping system.

F. Corporation Valves and Curb Valves: Install each underground curb valve with head pointed up and with service box.

G. Pressure-Reducing Valves: Install in vault or aboveground between shutoff valves.

H. Relief Valves: Comply with AWWA C512. Install aboveground with shutoff valve on inlet.

3.9 DETECTOR-CHECK VALVE INSTALLATION

A. Install in vault or aboveground.

B. Install for proper direction of flow. Install bypass with water meter, gate valves on each side of meter, and check valve downstream from meter.

C. Support detector check valves, meters, shutoff valves, and piping on brick or concrete piers.

3.10 VACUUM BREAKER ASSEMBLY INSTALLATION

A. Install pressure vacuum breaker assemblies of type, size, and capacity indicated. Include valves and test cocks. Install according to requirements of plumbing and health department and authorities having jurisdiction.

B. Do not install pressure vacuum breaker assemblies in vault or other space subject to flooding.

3.11 BACKFLOW PREVENTER INSTALLATION

A. Install backflow preventers of type, size, and capacity indicated. Include valves and test cocks. Install according to requirements of plumbing and health department and authorities having jurisdiction.

B. Do not install backflow preventers that have relief drain in vault or in other spaces subject to flooding.

C. Do not install bypass piping around backflow preventers.

D. Support NPS 2-1/2 and larger backflow preventers, valves, and piping near floor and on brick or concrete piers.

3.12 FIRE HYDRANT INSTALLATION

A. General: Install each fire hydrant with separate gate valve in supply pipe, anchor with restrained joints or thrust blocks, and support in upright position.

B. Wet-Barrel Fire Hydrants: Install with valve below frost line. Provide for drainage.

C. AWWA Fire Hydrants: Comply with AWWA M17.

D. UL/FMG Fire Hydrants: Comply with NFPA 24.

3.13 CONNECTIONS

A. Piping installation requirements are specified in other Division 2 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. See Division 2 Section "Piped Utilities - Basic Materials and Methods" for piping connections to valves and equipment.

C. Connect water-distribution piping to existing water main with tee and gate valve.

D. Connect water-distribution piping to interior domestic water and fire-suppression piping.

E. Ground equipment according to Division 16 Section "Grounding and Bonding."

F. Connect wiring according to Division 16 Section "Conductors and Cables."

3.14 FIELD QUALITY CONTROL

A. Piping Tests: Conduct piping tests before joints are covered and after concrete thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.

B. Hydrostatic Tests: Test at not less than one-and-one-half times working pressure for two hours.

1. Increase pressure in 50-psig increments and inspect each joint between increments. Hold at test pressure for 1 hour; decrease to 0 psig . Slowly increase again to test pressure and hold for 1 more hour. Maximum allowable leakage is 2 quarts per hour per 100 joints. Remake leaking joints with new materials and repeat test until leakage is within allowed limits.

C. Prepare reports of testing activities.

3.15 IDENTIFICATION

A. Install continuous underground warning tape during backfilling of trench for underground water-distribution piping. Locate below finished grade, directly over piping. Underground warning tapes are specified in Division 2 Section "Earthwork."

B. Permanently attach equipment nameplate or marker indicating plastic water-service piping, on main electrical meter panel. See Division 2 Section "Piped Utilities - Basic Materials and Methods" for identifying devices.

3.16 CLEANING

A. Clean and disinfect water-distribution piping as follows:

1. Purge new water-distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use.
2. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in AWWA C651 or do as follows:

    a. Fill system or part of system with water/chlorine solution containing at least 50 ppm of chlorine; isolate and allow to stand for 24 hours.
    b. Drain system or part of system of previous solution and refill with water/chlorine solution containing at least 200 ppm of chlorine; isolate and allow to stand for 3 hours.
    c. After standing time, flush system with clean, potable water until no chlorine remains in water coming from system.
    d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure if biological examination shows evidence of contamination.

B. Prepare reports of purging and disinfecting activities.

END OF SECTION 331100

SECTION 331300 - DISINFECTING OF WATER UTILITY DISTRIBUTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes disinfection of potable water distribution system; and testing and reporting results.

B. Related Sections:
1. Section 331116 - Site Water Distribution Product and Execution requirements for installation, testing, of site domestic water distribution piping.
2. Section 224000 - Plumbing Fixtures: Disinfection of building domestic water piping system.

1.2 REFERENCES

A. American Water Works Association:
1. AWWA B300 - Hypochlorites.
2. AWWA B302 - Ammonium Sulfate.
3. AWWA B303 - Sodium Chlorite.
4. AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.
5. AWWA C651 - Disinfecting Water Mains.

1.3 SUBMITTALS

A. Section 013000 - Administrative Requirements: Requirements for submittals.

B. Product Data: Submit procedures, proposed chemicals, and treatment levels for review.

C. Test Reports: Indicate results comparative to specified requirements.

D. Certificate: Certify cleanliness of water distribution system meets or exceeds specified requirements.

1.4 CLOSEOUT SUBMITTALS

A. Section 017000 – Execution and Closeout: Requirements for submittals.

B. Disinfection Report:
1. Type and form of disinfectant used.
2. Date and time of disinfectant injection start and time of completion.
3. Test locations.
4. Name of person collecting samples.
5. Initial and 24 hour disinfectant residuals in treated water in ppm for each outlet tested.
6. Date and time of flushing start and completion.
7. Disinfectant residual after flushing in ppm for each outlet tested.

C. Bacteriological Report:
1. Date issued, project name, and testing laboratory name, address, and telephone number.

2. Time and date of water sample collection.
3. Name of person collecting samples.
4. Test locations.
5. Initial and 24 hour disinfectant residuals in ppm for each outlet tested.
6. Coliform bacteria test results for each outlet tested.
7. Certify water conforms, or fails to conform, to bacterial standards of authority having jurisdiction.

D. Water Quality Certificate: Certify water conforms to quality standards of City of Hurricane, suitable for human consumption.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with AWWA C651.

1.6 QUALIFICATIONS

A. Water Treatment Firm: Company specializing in disinfecting potable water systems specified in this section with minimum three years documented experience.

B. Testing Firm: Company specializing in testing potable water systems, certified by State of Utah.

C. Submit bacteriologist's signature and authority associated with testing.

PART 2 - PRODUCTS

2.1 DISINFECTION CHEMICALS

A. Chemicals: AWWA B300, Hypochlorite, AWWA B301, Ammonium Sulfate, and AWWA B303, Sodium Chlorite.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 010400 – Project Coordination: Verification of existing conditions before starting work.

B. Verify piping system has been cleaned, inspected, and pressure tested.

C. Perform scheduling and disinfecting activity with start-up, water pressure testing, adjusting and balancing, demonstration procedures, including coordination with related systems.

3.2 INSTALLATION

A. Provide and attach required equipment to perform the Work of this section.

B. Perform disinfection of water distribution system and installation of system and pressure testing. Refer to Section 331116.

C. Introduce treatment into piping system.

D. Maintain disinfectant in system for 24 hours.

E. Flush, circulate, and clean until required cleanliness is achieved; use municipal domestic water.

F. Replace permanent system devices removed for disinfection.

3.3 FIELD QUALITY CONTROL

A. Section 010500 – Field Engineering: Field inspecting, testing, adjusting, and balancing.

B. Disinfection, Flushing, and Sampling:

1. Disinfect pipeline installation in accordance with AWWA C651. Use of liquid chlorine is not permitted
2. Upon completion of retention period required for disinfection, flush pipeline until chlorine concentration in water leaving pipeline is no higher than that generally prevailing in existing system or is acceptable for domestic use.
3. Legally dispose of chlorinated water. When chlorinated discharge may cause damage to environment, apply neutralizing chemical to chlorinated water to neutralize chlorine residual remaining in water.
4. After final flushing and before pipeline is connected to existing system, or placed in service, employ an approved independent testing laboratory to sample, test and certify water quality suitable for human consumption.

END OF SECTION 331300

SECTION 333000 - SANITARY SEWERAGE UTILITIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. All construction for the Sanitary Sewer lines will be according to the Cedar City Corporation design and standard specifications. Cedar City will be inspecting and approving the installation of the lines.

1.2 SUMMARY

A. Section Includes:

1. Pipe and fittings.
2. Nonpressure and pressure couplings.
3. Expansion joints and deflection fittings.
4. Backwater valves.
5. Cleanouts.
6. Encasement for piping.
7. Manholes.

1.3 DEFINITIONS

A. PVC: Polyvinyl Chloride pipe and fittings.

B. ABS: Acrylonitrile-Butadiene-Sturine pipe and fittings

1.4 SUBMITTALS

A. Shop Drawings: For manholes. Include plans, elevations, sections, details, and frames and covers.

B. Compaction testing results for installation of the sewer lines and manholes.

C. Field quality-control reports.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic manholes, pipe, and fittings in direct sunlight.

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

C. Handle manholes according to manufacturer's written rigging instructions.

1.6 PROJECT CONDITIONS

A. Interruption of Existing Sanitary Sewerage 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 two days in advance of proposed interruption of service.
2. Do not proceed with interruption of service without Construction Manager's written permission.

PART 2 - PRODUCTS

2.1 ABS PIPE AND FITTINGS

A. ABS Sewer Pipe and Fittings: ASTM D 2751, with bell-and-spigot ends for gasketed joints.

1. NPS 3 to NPS 6 : SDR 35.

B. Gaskets: ASTM F 477, elastomeric seals.

2.2 PVC PIPE AND FITTINGS

A. PVC Sewer Pipe and fittings:

1. Pipe: ASTM D 3034, SDR 35, PVC profile, gravity 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.

2.3 CLEANOUTS

A. PVC Cleanouts:
1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

a. Canplas LLC.
b. IPS Corporation.
c. NDS.
d. Plastic Oddities; a division of Diverse Corporate Technologies, Inc.
e. Sioux Chief Manufacturing Company, Inc.
f. Zurn Light Commercial Products Operation; Zurn Plumbing Products Group.

2. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

2.4 MANHOLES

A. Standard Precast Concrete Manholes:

1. Description: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
2. Diameter: 48 inches minimum unless otherwise indicated.
3. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.
4. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section; with separate base slab or base section with integral floor.
5. Riser Sections: 4-inch minimum thickness, of length to provide depth indicated.
6. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated; with top of cone of size that matches grade rings.
7. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
8. Resilient Pipe Connectors: ASTM C 923, cast or fitted into manhole walls, for each pipe connection.
9. Steps: Individual FRP steps conforming to ASTM 214, Type II grade 43758, with ASTM A 615, deformed, 1/2-inch steel reinforcing rods encased in ASTM D 4101, PP; wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches.
10. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, with diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope.

B. Manhole Frames and Covers:

1. Description: Ferrous; 24-inch ID by 7- to 9-inch riser, with 4-inch-minimum-width flange and 26-inch- diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "SEWER."
2. Material: ASTM A 48, Class 35 gray iron unless otherwise indicated.

2.5 CONCRETE

A. General: Cast-in-place concrete complying with ACI 318 and the following:

1. Cement: ASTM C 150, Type II.
2. Fine Aggregate: ASTM C 33, sand.
3. Coarse Aggregate: ASTM C 33, crushed gravel.
4. Water: Potable.

B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A 185, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A 615, Grade 60 deformed steel.

C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.

1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.

a. Invert Slope: 1 percent through manhole.

2. Benches: Concrete, sloped to drain into channel.

a. Slope: 4 percent.

D. Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.58 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A 185, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A 615, Grade 60 deformed steel.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Division 2 Section "Earthwork."

3.2 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground sanitary sewer piping. Location and arrangement of piping layout

take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

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 using lubricants, cements, and other installation requirements.

C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

D. Install 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. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.

F. Install gravity-flow, nonpressure, drainage piping according to the following:

1. Install piping pitched down in direction of flow, at minimum slope of 0.5 percent unless otherwise indicated.
2. Install piping with 48-inch minimum cover.
3. Install ABS sewer piping according to ASTM D 2321 and ASTM F 1668.
4. Install PVC gravity sewer piping according to ASTM D 2321 and ASTM F 1668.

3.3 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, nonpressure, drainage piping according to the following:
1. Join ABS sewer piping according to ASTM D 2321 and ASTM D 2751 for elastomeric-seal joints.
2. Join PVC gravity sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasket joints.

3.4 MANHOLE INSTALLATION

A. General: Install manholes complete with appurtenances and accessories indicated.

B. Install precast concrete manhole sections with sealants according to ASTM C 891.

C. Form continuous concrete channels and benches between inlets and outlet.

D. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 6 inches above finished surface elsewhere unless otherwise indicated.

E. Install manhole-cover inserts in frame and immediately below cover.

3.5 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318.

3.6 CLEANOUT INSTALLATION

A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Install piping so cleanouts open in direction of flow in sewer pipe.

1. Use Light-Duty, top-loading classification cleanouts in earth or unpaved foot-traffic areas.
2. Use Medium-Duty, top-loading classification cleanouts in paved foot-traffic areas.
3. Use Heavy-Duty, top-loading classification cleanouts in vehicle-traffic service areas.
4. Use Extra-Heavy-Duty, top-loading classification cleanouts in roads.

B. Set cleanout frames and covers in earth in cast-in-place-concrete block, 18 by 18 by 12 inches deep. Set with tops 1 inch above surrounding grade.

C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.7 CONNECTIONS

A. Connect nonpressure, gravity-flow drainage piping to building's sanitary building drains specified in Division 15 Section "Sanitary Waste and Vent Piping."

B. Make connections to existing piping and underground manholes as required and per Cedar City Corporation standards and specifications.

1. Protect existing piping and manholes to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

C. Connect to grease, oil, and sand interceptors specified in Division 2 Section "Interceptors."

3.8 CLOSING ABANDONED SANITARY SEWER SYSTEMS

A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use procedure below:

1. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.

B. Abandoned Manholes: Excavate around manhole as required and remove manhole and close open ends of remaining piping.

C. Backfill to grade according to Division 2 Section "Earthwork."

3.9 IDENTIFICATION

A. Materials and their installation are specified in Division 2 Section "Earthwork." Arrange for installation of green warning tapes directly over piping and at outside edges of underground manholes.

1. Use warning tape over ferrous piping.
2. Use warning tape over nonferrous piping and over edges of underground manholes.

3.10 FIELD QUALITY CONTROL

A. Cedar City Corporation will inspect the installation of all sanitary sewer main lines and manholes located in street right of ways. Contact Jason Fuson at Cedar City Engineering to schedule inspections of the installation. Contractor will be responsible to satisfy City requirements for Sanitary sewer installation.

1. 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. Damage: Crushed, broken, cracked, or otherwise damaged piping.
   d. Infiltration: Water leakage into piping.
   e. Exfiltration: Water leakage from or around piping.

2. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
3. Reinspect and repeat procedure until results are satisfactory.

B. 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 requirements of authorities having jurisdiction.
3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
4. Submit separate report for each test.
5. Hydrostatic Tests: Test sanitary sewerage according to requirements of Cedar City Corporation and the following:

a. Fill sewer piping with water. Test with pressure, and maintain such pressure without leakage for at least 15 minutes.
b. Close openings in system and fill with water.
c. Purge air and refill with water.
d. Disconnect water supply.
e. Test and inspect joints for leaks.

6. Air Tests: Test sanitary sewerage according to requirements of Cedar City Corporation, UNI-B-6, and the following:

a. Test plastic gravity sewer piping according to ASTM F 1417.

7. Manholes: Perform hydraulic test according to ASTM C 969.

C. Leaks and loss in test pressure constitute defects that must be repaired.

D. All trenches and backfilling are required to have compaction testing during backfill operation per Cedar City requirements.

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

3.11 CLEANING

A. Clean dirt and superfluous material from interior of piping. Flush with potable water.

END OF SECTION 333000

SECTION 334000 - STORM DRAINAGE UTILITIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Pipe and fittings.
2. Nonpressure transition couplings.
3. Expansion joints and deflection fittings.
4. Cleanouts.
5. Drains.
6. Encasement for piping.
7. Manholes.
8. Channel drainage systems.
9. Catch basins.
10. Stormwater inlets.
11. Pipe outlets.
12. Stormwater disposal systems.

1.3 DEFINITIONS

A. PVC: Polyvinyl Chloride pipe and fittings.

B. HDPE: High Density Polyethylene pipe and fittings.

1.4 SUBMITTALS

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

B. Field quality-control reports.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic manholes, pipe, and fittings in direct sunlight.

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

C. Handle manholes according to manufacturer's written rigging instructions.

D. Handle catch basins and stormwater inlets according to manufacturer's written rigging instructions.

1.6 PROJECT 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 two days in advance of proposed interruption of service.
2. Do not proceed with interruption of service without Construction Manager's written permission.

PART 2 - PRODUCTS

2.1 ABS PIPE AND FITTINGS

A. ABS Sewer Pipe and Fittings: ASTM D 2751, with bell-and-spigot ends for gasketed joints.

1. NPS 3 to NPS 6: SDR 35.
2. NPS 8 to NPS 12: SDR 42.

B. Gaskets: ASTM F 477, elastomeric seals.

2.2 HDPE PIPE AND FITTINGS

A. Corrugated HDPE Drainage Pipe and Fittings NPS 3 to NPS 10: AASHTO M 252M, Type S, with smooth waterway for coupling joints.

1. Silttight Couplings: HDPE sleeve with ASTM D 1056, Type 2, Class A, Grade 2 gasket material that mates with tube and fittings.
2. Soiltight Couplings: AASHTO M 252M, corrugated, matching tube and fittings.

B. Corrugated HDPE Pipe and Fittings NPS 12 to NPS 60: AASHTO M 294M, Type S, with smooth waterway for coupling joints.

1. Silttight Couplings: HDPE sleeve with ASTM D 1056, Type 2, Class A, Grade 2 gasket material that mates with pipe and fittings.
2. Soiltight Couplings: AASHTO M 294M, corrugated, matching pipe and fittings.

2.3 PVC PIPE AND FITTINGS

A. PVC Gravity Sewer Piping:

1. Pipe and Fittings: ASTM F 679, PVC gravity sewer pipe with bell-and-spigot ends and with integral ASTM F 477, elastomeric seals for gasketed joints.

2.4 NONPRESSURE TRANSITION COUPLINGS

A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.

B. Sleeve Materials:
1. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
2. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

C. Unshielded, Flexible Couplings:
1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

a. Dallas Specialty & Mfg. Co.
b. Fernco Inc.
c. Logan Clay Pipe.
d. Mission Rubber Company; a division of MCP Industries, Inc.
e. NDS Inc.
f. Plastic Oddities; a division of Diverse Corporate Technologies, Inc.

2. Description: Elastomeric sleeve with stainless-steel shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.

D. Shielded, Flexible Couplings:
1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

a. Cascade Waterworks Mfg.
b. Dallas Specialty & Mfg. Co.
c. Mission Rubber Company; a division of MCP Industries, Inc.

2. Description: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

E. Ring-Type, Flexible Couplings:
1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

a. Fernco Inc.
b. Logan Clay Pipe.
c. Mission Rubber Company; a division of MCP Industries, Inc.

2. Description: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.

2.5 CLEANOUTS

A. Plastic Cleanouts:

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

a. Canplas LLC.
b. IPS Corporation.
c. NDS Inc.
d. Plastic Oddities; a division of Diverse Corporate Technologies, Inc.
e. Sioux Chief Manufacturing Company, Inc.
f. Zurn Light Commercial Products Operation; Zurn Plumbing Products Group.

2. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

2.6 DRAINS

A. Drains to be cast in place or precast concrete boxes with an open steel removable grate to allow access for maintenance. The grate should be capable of handling 2,000 lb loading. Subject to compliance with requirements, provide product indicated on Drawings or comparable product

2.7 MANHOLES

A. Standard Precast Concrete Manholes:

1. Description: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
2. Diameter: 48 inches minimum unless otherwise indicated.
3. Ballast: Increase thickness of precast concrete sections or add concrete to base section as required to prevent flotation.
4. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
5. Riser Sections: 4-inch minimum thickness, and lengths to provide depth indicated.
6. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated, and top of cone of size that matches grade rings.

7. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
8. Resilient Pipe Connectors: ASTM C 923, cast or fitted into manhole walls, for each pipe connection.
9. Steps: Individual FRP steps; ASTM A 615/A 615M, deformed, 1/2-inch steel reinforcing rods encased in ASTM D 4101, PP, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of manhole to finished grade is less than 48 inches.
10. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, to match diameter of manhole frame and cover, and height as required to adjust manhole frame and cover to indicated elevation and slope.

2.8 CONCRETE

A. General: Cast-in-place concrete according to ACI 318, and the following:

1. Cement: ASTM C 150, Type II.
2. Fine Aggregate: ASTM C 33, sand.
3. Coarse Aggregate: ASTM C 33, crushed gravel.
4. Water: Potable.

B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A 185 steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A 615, Grade 60 deformed steel.

C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.

1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.

   a. Invert Slope: 1 percent through manhole.

2. Benches: Concrete, sloped to drain into channel.

   a. Slope: 4 percent.

D. Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.58 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A 185, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A 615, Grade 60 deformed steel.

2.9 CATCH BASINS

A. Standard Precast Concrete Catch Basins:

1. Description: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
2. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
3. Riser Sections: 4-inch minimum thickness, and lengths to provide depth indicated.
4. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.
5. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
6. Grade Rings: Top of catch basin to be cast in place concrete to match to gutter or finished ground elevations.

B. Frames and Grates: ASTM A 536, Grade 60-40-18, ductile iron designed for A-16, structural loading. Include flat grate with small square or short-slotted drainage openings.

1. Size: 18 by 18 inches minimum unless otherwise indicated.
2. Grate Free Area: Approximately 50 percent unless otherwise indicated.

See Division 5 Section "Gratings" for fabricated-steel grating.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavation, trenching, and backfilling are specified in Division 2 Section "Earthwork."

3.2 PIPING INSTALLATION

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 into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

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. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

D. Install 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. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.

F. Install gravity-flow, nonpressure drainage piping according to the following:

1. Install piping pitched down in direction of flow.
2. Install piping NPS 6 and larger with restrained joints at tee fittings and at changes in direction.
3. Install piping with 12" minimum cover.
4. Install PVC profile gravity sewer piping according to ASTM D 2321 and ASTM F 1668.

3.3 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, nonpressure drainage piping according to the following:
1. Join ABS sewer piping according to ASTM D 2321 and ASTM D 2751 for elastomeric-seal joints.
2. Join corrugated PE piping according to ASTM D 3212 for push-on joints.
3. Join PVC profile gravity sewer piping according to ASTM D 2321 for elastomeric-seal joints or ASTM F 794 for gasketed joints.
4. Join nonreinforced-concrete sewer piping according to ASTM C 14 and ACPA's "Concrete Pipe Installation Manual" for rubber-gasketed joints.
5. Join reinforced-concrete sewer piping according to ACPA's "Concrete Pipe Installation Manual" for rubber-gasketed joints.
6. Join dissimilar pipe materials with nonpressure-type flexible couplings.

3.4 CLEANOUT INSTALLATION

A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Install piping so cleanouts open in direction of flow in sewer pipe.

1. Use Light-Duty, top-loading classification cleanouts in earth or unpaved foot-traffic areas.
2. Use Medium-Duty, top-loading classification cleanouts in paved foot-traffic areas.
3. Use Heavy-Duty, top-loading classification cleanouts in vehicle-traffic service areas.
4. Use Extra-Heavy-Duty, top-loading classification cleanouts in roads .

B. Set with tops 1 inch above surrounding earth grade.

C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface. Set cleanout frames and covers in pavement in cast-in-place-concrete block, 18 by 18 by 12 inches deep.

D.

3.5 MANHOLE INSTALLATION

A. General: Install manholes, complete with appurtenances and accessories indicated.

B. Install precast concrete manhole sections with sealants according to ASTM C 891.

C. Where specific manhole construction is not indicated, follow manhole manufacturer's written instructions.

D. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 6 inches above finished surface elsewhere unless otherwise indicated.

3.6 CATCH BASIN INSTALLATION

A. Construct catch basins to sizes and shapes indicated.

B. Set frames and grates to elevations indicated.

3.7 STORMWATER INLET AND OUTLET INSTALLATION

A. Construct inlet head walls, aprons, and sides of reinforced concrete, as indicated.

B. Install outlet into curb and gutter per detail shown and Cedar City specifications.

C. Install outlets that spill onto grade, anchored with concrete, where indicated.

D. Install outlets that spill onto grade, with flared end sections that match pipe, where indicated.

E. Construct energy dissipaters at outlets, as indicated.

3.8 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318.

3.9 CLOSING ABANDONED STORM DRAINAGE SYSTEMS

A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use procedure below:
   1. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.

B. Abandoned Manholes and Structures: Excavate around manholes and structures as required and remove manhole or structure and close open ends of remaining piping.

C. Backfill to grade according to Division 2 Section "Earthwork."

3.10 IDENTIFICATION

A. Materials and their installation are specified in Division 2 Section "Earthwork." Arrange for installation of green warning tape directly over piping and at outside edge of underground structures.

1. Use warning tape over ferrous piping.
2. Use warning tape over nonferrous piping and over edges of underground structures.

3.11 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of 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. Damage: 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.

B. 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 requirements of authorities having jurisdiction.
3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
4. Submit separate report for each test.
5. Gravity-Flow Storm Drainage Piping: Test according to requirements of authorities having jurisdiction, UNI-B-6, and the following:

a. Exception: Piping with soiltight joints unless required by authorities having jurisdiction.
b. Option: Test plastic piping according to ASTM F 1417.
c. Option: Test concrete piping according to ASTM C 924.
d.

C. Leaks and loss in test pressure constitute defects that must be repaired.

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

3.12 CLEANING

A. Clean interior of piping of dirt and superfluous materials. Flush with water.

END OF SECTION 334000