PROJECT MANUAL FOR

EMERGENCY MEDICAL SERVICES STATION NO.3

Kendall County

40 Voss Parkway
Boerne, Texas 78006

100% Construction Documents - ***VOLUME 2 OF 2***

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August 15th, 2023
BPA Project No. 22-41

PROJECT MANUAL

KENDALL COUNTY EMERGENCY MEDICAL SERVICES STATION NO.3

BPA PROJECT NO. 22-41

August 15th, 2023

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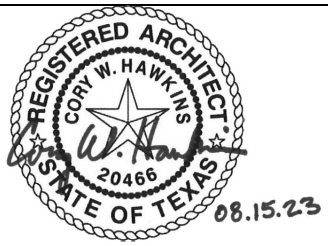

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SUPPLEMENTAL DOCUMENTATION

Geotechnical Engineering Report by Terracon, Project No. 90235101, dated May 12th, 2023

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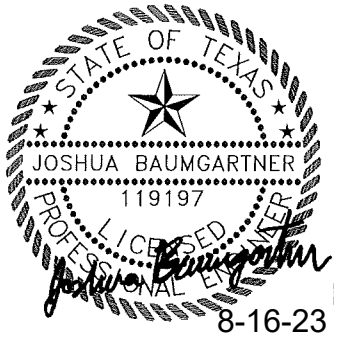
KENDALL COUNTY EMERGENCY MEDICAL SERVICES STATION NO.3

CNG PROJECT NO. 22-0078

PLUMBING



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ELECTRICAL

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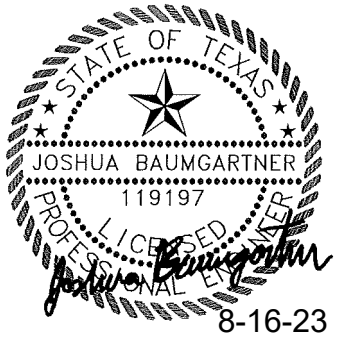
MECHANICAL



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SECTION 210517 - SLEEVES AND SLEEVE SEALS FOR FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. See Division 07, Thermal and Moisture Protection, for all firestop requirements.

1.2 SUMMARY

A. Section Includes:
1. Sleeves.
2. Stack-sleeve fittings.
3. Sleeve-seal systems.
4. Sleeve-seal fittings.
5. Grout.

1.3 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/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.

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

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

2.2 STACK-SLEEVE FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Smith, Jay R. Mfg. Co.
2. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.

B. 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.

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 or Stainless steel.
   3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating, or Stainless steel of length required to secure pressure plates to sealing elements.
   4. Install 1-hour Factory Mutual (FM) approved, silicone sealing elements, carbon steel zinc dichromated pressure plates, connecting bolts and nuts where required.

2.4 SLEEVE-SEAL FITTINGS

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

B. 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 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 "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 "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 Division 07 Section "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.

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: Will be Cast-iron wall sleeves as required.
2. Exterior Concrete Walls below Grade: Will be Cast-iron wall sleeves with sleeve-seal system as required. 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: Will be Cast-iron wall sleeves with sleeve-seal system as required. 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: Will be PVC-pipe sleeves as required.

END OF SECTION 210517

SECTION 210518 - ESCUTCHEONS FOR FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Escutcheons.
2. Floor plates.

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 and rough-brass finish and setscrew fastener.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.

C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.

D. Split-Casting Brass Type: With polished, chrome-plated and rough-brass finish and with concealed hinge and setscrew.

E. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed hinge, and spring-clip fasteners.

2.2 FLOOR PLATES

A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

B. Split-Casting Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

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

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
   1. Escutcheons for New Piping:
      a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
      b. Chrome-Plated Piping: One-piece, cast-brass type with polished, chrome-plated finish.
      c. Insulated Piping: One-piece, stamped-steel type.
      d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
      e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
      f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
      g. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type.
      h. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with rough-brass finish.
      i. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type.
      j. Bare Piping in Equipment Rooms: One-piece, cast-brass type with rough-brass finish.
      k. Bare Piping in Equipment Rooms: One-piece, stamped-steel type.
   2. Escutcheons for Existing Piping:
      a. Chrome-Plated Piping: Split-casting brass type with polished, chrome-plated finish.
      b. Insulated Piping: Split-plate, stamped-steel type with concealed hinge.
      c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
      d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge.
      e. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
      f. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge.
      g. Bare Piping in Unfinished Service Spaces: Split-casting brass type with rough-brass finish.
      h. Bare Piping in Unfinished Service Spaces: Split-plate, stamped-steel type with concealed hinge.
      i. Bare Piping in Equipment Rooms: Split-casting brass type with rough-brass finish.
      j. Bare Piping in Equipment Rooms: Split-plate, stamped-steel type with concealed hinge.

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

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
   1. New Piping: One-piece, floor-plate type.
   2. Existing Piping: Split-casting, floor-plate type.

3.2 FIELD QUALITY CONTROL

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

END OF SECTION 210518

SECTION 210529 - HANGERS AND SUPPORTS FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Fiberglass pipe hangers.
4. Metal framing systems.
5. Fiberglass strut systems.
6. Thermal-hanger shield inserts.
7. Fastener systems.
8. Equipment supports.

B. Related Sections:
1. Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment" for vibration isolation devices.

1.3 DEFINITIONS

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

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

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

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.
   3. Fiberglass strut systems.
   4. Pipe stands.
   5. Equipment supports.

C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   1. Detailed fabrication and assembly of trapeze hangers.
   2. Design Calculations: Calculate requirements for designing trapeze hangers.

1.6 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.7 QUALITY ASSURANCE

A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:
   1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
   2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
   3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
   4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
   5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Stainless-Steel Pipe Hangers and Supports:
   1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
   2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
   3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

C. Copper Pipe Hangers:

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

2.2 TRAPEZE PIPE HANGERS

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

2.3 FIBERGLASS PIPE HANGERS

A. Clevis-Type, Fiberglass Pipe Hangers:
1. Description: Similar to MSS SP-58, Type 1, steel pipe hanger except hanger is made of fiberglass or fiberglass-reinforced resin.
2. Hanger Rods: Continuous-thread rod, washer, and nuts made of fiberglass.

B. Strap-Type, Fiberglass Pipe Hangers:
1. Description: Similar to MSS SP-58, Type 9 or Type 10, steel pipe hanger except hanger is made of fiberglass-reinforced resin.
2. Hanger Rod and Fittings: Continuous-thread rod, washer, and nuts made of stainless steel.

2.4 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Allied Tube & Conduit.
   b. Cooper B-Line, Inc.
   c. Flex-Strut Inc.
   d. GS Metals Corp.
   e. Thomas & Betts Corporation.
   f. Unistrut Corporation; Tyco International, Ltd.
   g. Wesanco, Inc.
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: Hot-dipped galvanized.
8. Paint Coating: Epoxy.
9. Plastic Coating: Epoxy.

2.5 FIBERGLASS STRUT SYSTEMS

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

1. Allied Tube & Conduit.
2. Champion Fiberglass, Inc.
3. Cooper B-Line, Inc.
4. SEASAFE, INC.; a Gibraltar Industries Company.

B. Description: Shop- or field-fabricated pipe-support assembly similar to MFMA-4 for supporting multiple parallel pipes.
1. Channels: Continuous slotted fiberglass channel with inturned lips.
2. Channel Nuts: Fiberglass nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of fiberglass.

2.6 THERMAL-HANGER SHIELD INSERTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Clement Support Services.
2. Pipe Shields Inc.
3. Piping Technology & Products, Inc.
4. Value Engineered Products, Inc.

B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.

C. Insulation-Insert Material for Hot Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.

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

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

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

2.7 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type, stainless- steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.8 PIPE STANDS

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

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

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

D. High-Type, Single-Pipe Stand:
1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
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:
1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
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 supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.9 PIPE POSITIONING SYSTEMS

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

2.10 EQUIPMENT SUPPORTS

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

2.11 MISCELLANEOUS MATERIALS

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

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

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

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

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

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
   1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
   2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Fiberglass Pipe-Hanger Installation: Comply with applicable portions of MSS SP-69 and MSS SP-89. Install hangers and attachments as required to properly support piping from building structure.

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

E. Fiberglass Strut System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled fiberglass struts.

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

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

H. Pipe Stand Installation:
   1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount them on smooth roof surface. Do not penetrate roof membrane.
   2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 077200 "Roof Accessories" for curbs.

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

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

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

L. 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.

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

N. 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.

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

P. 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.

Q. 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 EQUIPMENT SUPPORTS

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

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

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

3.3 METAL FABRICATIONS

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

B. Fit exposed connections together to form hairline joints. Field weld connections 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 undercutting or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

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

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

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

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

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

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

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

E. Use carbon-steel pipe hangers and supports metal trapeze pipe hangers and metal framing systems and attachments for general service applications.

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

G. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.

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

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

J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
   2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
   3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
   4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
   5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
   6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
   7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
   8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
   9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.

10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is 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.

K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

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

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

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

N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.

5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
    a. Horizontal (MSS Type 54): Mounted horizontally.
    b. Vertical (MSS Type 55): Mounted vertically.
    c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

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

Q. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

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

S. Use pipe positioning systems in pipe spaces behind fire-suppression fixtures to support supply and waste piping for fire-suppression fixtures.

END OF SECTION 210529

SECTION 210553 - IDENTIFICATION for FIRE-SUPPRESSION PIPING and EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Stencils.
5. Valve tags.
6. Warning tags.
7. Comply with NFPA/Factory Mutual guidelines.

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.

D. Refer to Section 210500 "Common Work Results for Fire-Suppression."

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Plastic Labels for Equipment:
1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1.8 thick, and having predrilled holes for attachment hardware.
2. Letter Color: Black.
3. Background Color: White.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F

5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

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

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

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: Black Blue Red White Yellow.

C. Background Color: Black Blue Red White 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 partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.

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

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
   1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
   2. Lettering Size: At least 1-1/2 inches high.

2.4 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;

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.

2.5 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 Approximately 4 by 7 inches.
   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 encapsulates.

3.2 EQUIPMENT LABEL INSTALLATION

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 or permanently fasten labels on each major item of fire suppression equipment.

D. Locate equipment labels where accessible and visible.

E. All labels shall follow requirements of locally-adopted codes.

3.3 PIPE LABEL INSTALLATION

A. All labels shall follow requirements of locally-adopted codes. Locate pipe labels where piping is exposed or above accessible ceilings in machine rooms, in accessible

maintenance spaces such as shafts, tunnels, and plenums, in non-public exterior exposed locations, or above accessible ceilings in finished spaces. Omit labels where piping is exposed in finished spaces or public exterior locations unless required by authority having jurisdiction. Specific label locations shall be as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 25 feet along each run; reduce intervals to 15 feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings, omit intermediately spaced labels.
8. Label to identify as Wet, Pre-Action, and Dry-Pipe Etc. System.

B. Pipe Label Color Schedule:
   1. Wet-Pipe Fire-Suppression Piping:
      a. Background Color: Red.
      b. Letter Color: White.
   2. Dry-Pipe Fire-Suppression Piping:
      a. Background Color: Red.
      b. Letter Color: White.
   3. Pre -Action Fire-Suppression Piping:
      a. Background Color: Red.
      b. Letter Color: White.

3.4 VALVE-TAG INSTALLATION

A. All tags shall follow requirements of locally-adopted codes. 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. Fire-Suppression Standpipe: 1-1/2 inches, round.
      b. Wet-Pipe Sprinkler System: 1-1/2 inches round.
      c. Dry-Pipe Sprinkler System: 1-1/2 inches round.
      d. Pre-Action Sprinkler System: 1-1/2 inches round.
      e. Foam-Water System: 1-1/2 inches round.
      f. Clean-Agent Fire-Extinguishing System: 1-1/2 inches round.

3.5 WARNING-TAG INSTALLATION

A. All tags shall follow requirements of locally-adopted codes. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 210553

SECTION 220500 - COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Piping materials and installation instructions are common to most piping systems.
2. Mechanical sleeve seals.
3. Sleeves.
4. Escutcheons.
5. Grout.
6. Equipment installation requirements common to equipment sections.
7. Painting and finishing.
8. Concrete bases.
9. Supports and anchorages.

1.3 DEFINITIONS

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

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

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

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

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

F. The following are industry abbreviations for plastic materials:
1. CPVC: Chlorinated 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. Mechanical sleeve seals.

2. 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.

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 Panels."

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 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.

G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

H. Solvent Cements for Joining CPVC Plastic Piping: ASTM F 493.

2.4 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: Carbon steel. Include two for each sealing element.
   4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.5 SLEEVES

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

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

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

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

E. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.

F. PVC Pipe: ASTM D 1785, Schedule 40.

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

2.6 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.
   2. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
   3. Finish: Polished chrome-plated.

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, screw or spring clips, and chrome-plated finish.

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

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

2.7 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
   1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
   2. Design Mix: 5000-psi, 28-day compressive strength.
   3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 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 Ceiling Penetrations in Finished Spaces: One-piece or split-casting, cast-brass type with polished chrome-plated finish.
      f. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated finish.
      g. Bare Piping in Equipment Rooms: One-piece, cast-brass type.
      h. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

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

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. 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.

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 21 Sections specifying piping systems.

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

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

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

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

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

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

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

I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
   1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
   2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.

J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.

3.3 PAINTING

A. Painting of fire-suppression systems, equipment, and components is specified in Division 09 Section “Painting and Coating."

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

3.4 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 "Concrete."

3.5 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 05 Section "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor fire-suppression materials and equipment.

C. Field Welding: Comply with AWS D1.1.

3.6 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor plumbing materials and equipment.

B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

3.7 GROUTING

A. Mix and install grout for fire-suppression 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.

3.8 DEMOLITION AND RELOCATION

A. The Contractor shall modify, remove, and relocate all materials and items so indicated on the Drawings or required by the installation of new facilities. All removals and/or dismantling shall be conducted in a manner as to produce maximum salvage. Salvage materials except asbestos shall remain the property of the Owner, and shall be delivered to such destination as directed by the Owner. Non-salvageable materials and equipment shall become the property of the Contractor and removed from the site.

B. Asbestos abatement is being performed under a separate contract. There have been no tests for existence of asbestos or other potentially hazardous materials within this facility. The Contractor shall immediately notify the Owner of any area where the Contractor suspects or becomes aware of the existence of asbestos or other potentially hazardous materials on this project. It shall be the responsibility of the Contractor to provide written request to the Owner for the services of an Industrial Hygienist who shall provide all necessary testing, analysis and documentation of the status of any areas where asbestos or potentially hazardous materials exist. The Industrial Hygienist shall then prepare plans and specifications which provide for the removal of all potentially hazardous substances and their disposal in a lawful manner. The Contractor shall not remove or disturb asbestos or other potentially hazardous substances until he has obtained approval in writing of the methods he shall use from the authorities having jurisdiction.

C. All items which are to be relocated shall be carefully removed in reverse to original assembly or placement and protected until relocated. The Contractor shall clean and repair and provide all new materials, fittings, and appurtenances required to complete the relocation and to restore to good operative order. All relocations shall be performed by workmen skilled in the work and in accordance with standard practice of the trades involved. Where items scheduled for relocation and/or reuse are found to be in damaged condition before work has been started on dismantling, the Contractor shall call the attention of the Owner to such items and receive further instructions before removal. Items damaged in repositioning operations are the Contractor's responsibility and shall be repaired or replaced by the Contractor as approved by the Owner, at no additional cost to the Owner or the Architect and Engineer. The Contractor may, at his discretion, and upon the approval of the Owner, substitute new materials and items of like design and quality in lieu of materials and items to be relocated.

D. Service lines and wiring to items to be removed, salvaged, or relocated shall be removed to points acceptable to the Owner. Service lines and wiring not scheduled for reuse shall be removed to the points at which reuse is to be continued or service is to remain. Such services shall be sealed, capped, or otherwise tied-off or disconnected in a safe manner acceptable to the Owner.

E. Cleanup: It shall be the responsibility of each trade to cooperate fully with the other trades on the job to keep the jobsite in a clean and safe condition. At the end of each day's work, each trade shall properly store all of his tools, equipment and materials and shall clean his debris from the job.

END OF SECTION 220500

SECTION 220510 - BASIC REQUIREMENTS 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

B. The requirements set out in Bidders Documents, Contract Forms, General Conditions, Supplementary General Conditions and Special Conditions apply to all work specified in the sections of this division.

C. A division is a group of related sections and a section covers one portion of the total work or requirements. It describes a particular material or product and its installation.

D. Work covered by the Mechanical Sections of these Specifications shall include the furnishing of all materials, labor, taxes, transportation, safe working conditions, tools, permits, fees, inspections, utilities and incidentals necessary for the complete and operable installation of all mechanical systems.

E. Under these Contract Documents, the Contractor shall provide an installation that is complete in every respect. The Contractor shall include additional details or special construction as required for work indicated or specified in this section or work specified in other sections. It shall be the responsibility of the Contractor to provide all material and equipment which is usually furnished with such systems in order to complete the installation, whether mentioned or not.

F. The Contractor shall be responsible for the coordination and proper relation of the work to the building structure and to the work of all trades. The Contractor shall visit the premises and become familiar with the existing site conditions, and all details of the work and the working conditions and to verify all dimensions and elevations in the field. The Contractor shall advise the Architect and the Engineer of any discrepancy prior to bidding. The submission of bids shall be deemed evidence of the Contractor's site visit, the verification and coordination of all existing conditions, and the inclusion of all considerations related to the existing conditions.

G. The responsibility for the furnishing of the proper equipment and/or material and the responsibility for seeing that it is installed as intended by the manufacturer rests entirely upon the Contractor. The Contractor shall consult and request advice and supervisory assistance from the representative of the specific manufacturer for proper installation, operation, and startup. The manufacturers' published instructions shall be followed for preparing, assembling, installing, erecting, and cleaning manufactured materials or equipment. The Contractor shall promptly notify the Architect and the Engineer in writing of any conflict between the requirements of the contract documents and the manufacturers' directions and shall obtain the Architect's and Engineer's instructions before proceeding with the work. Should the Contractor perform any such work that does not comply with the manufacturer's directions or such instructions from the Architect and Engineer, he shall bear all resulting costs that may arise from any system or

equipment deficiencies.

1.3 DRAWINGS AND SPECIFICATIONS

A. These Specifications are accompanied by Drawings of the building and details of the installations indicating the locations of equipment, piping, ductwork, outlets, light fixtures, etc. Items specifically mentioned in the Specifications but not shown on the Drawings and items shown on the Drawings but not specifically mentioned in the Specifications shall be installed by the Contractor under the appropriate section of work as if they were indicated by both.

B. If departures from the Drawings are deemed necessary by the Contractor, details of such departures and the reasons therefor shall be submitted to the Architect and the Engineer for review. No departures shall be made without prior written acceptance of the Architect and the Engineer.
   1. The interrelation of the Specifications, the Drawings, and the schedules is generally as follows: The Specifications determine the nature and setting of the several materials, the Drawings establish the quantities, dimensions, and details, and the schedules give the performance characteristics.

1.4 SUBMITTALS

A. After the Contract is awarded, but prior to proceeding with the Work, the Contractor shall obtain, check, certify, and submit complete Shop Drawings and Brochures from Manufacturers, Suppliers, Vendors, etc., for all materials and equipment specified herein. Submit Shop Drawings and Brochures in sufficient time so as not to impede the progress of Work. Four weeks will be required for the processing of Shop Drawings and Brochures in the Engineer's office, exclusive of transmittal time. This time shall be considered by the Contractor when scheduling submittal data. After the Contract is awarded, the Contractor will advise the Engineer in writing of the schedule for submission of shop drawings and product data and the persons authorized to sign submittal data on behalf of the Company.

B. The Engineer's review of Shop Drawings and Brochures shall not relieve the Contractor of the responsibility for dimensions, errors that may be contained therein, or deviations from Contract Document requirements. It shall be clearly understood that the Engineer's noting some errors but overlooking others does not grant the Contractor permission to proceed in error. Contractor shall refer to Section 23 0593 "Testing, Adjusting, and Balancing for HVAC" for all test and balance rough-in requirements. Contractor shall ascertain all equipment electrical requirements are coordinated with Division 26 and electrical drawings. Contractor shall confirm all shop drawings reflect coordination with structural and all other trades and are free of interferences. Regardless of any information contained in the Shop Drawings, the requirements of the Contract Documents shall govern and are not waived or superseded in any way by the submittal data review.

C. Before submission of Shop Drawings and Brochures, the Contractor shall certify that each Shop Drawing and each item of material or equipment complies with the Contract Documents for this Project. Such certification shall be made by the Owner, a Partner, a Corporate Officer of the Contractor, or by a person duly authorized to sign for the Contractor. Unless so certified, Shop Drawings and/or Brochures will be returned for resubmittal. Certifications shall be in the form of rubber stamp impressions or typed letter which states:

> I hereby certify that this Shop Drawing and/or brochure and the equipment and material shown on this Shop Drawing and/or Brochure complies in all respects (except as noted*) with the requirements of the Contract Documents for this Project. I further certify that all data shown herein as to performance, dimensions, construction, materials, and other pertinent items are true and correct.
>
> (Name of Contractor) _____
>
> Signed _____
>
> Position _____
>
> Date _____
> * Refer to exception requirements herein.

D. 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 Sheet or Brochure; name and location of the building; names of the Architect, Engineer, Contractor, Manufacturer, Supplier, Vendor, etc., the date of submittal; and the date of each correction and revision. So far as is practical, each Shop Drawing and/or Brochure shall bear a cross-reference note to the sheet number or numbers of the Contract Drawings and Specifications showing the same work. Shop Drawings and Brochures shall be prepared as follows:

1. Shop Drawings: Drawings shall be newly prepared and not reproduced from the contract documents, drawn to a scale that can be easily read and shall contain sufficient plans, elevations, sections, and isometrics to describe clearly the items in question. Drawings shall be prepared by a draftsman skilled in this type of work. All piping, equipment layouts, ductwork and similar Shop Drawings shall be drawn to at least 1/4" = 1'-0" scale.
2. Brochures: Brochures submitted to the Engineer shall be published by the Manufacturers and shall contain complete and detailed engineering and dimensional information to show that the equipment will fit into the allotted space.
3. Brochures submitted shall contain only information which is relevant to the particular equipment and applicable accessories that are required for sale and efficient operation of the systems or materials to be furnished. Do not submit catalogs that describe several different items other than those items to be used unless all irrelevant information is marked out or relevant information is clearly marked.

E. The submittal format shall follow the Specifications format with a submittal required for each section of Division 22. The submittal shall be contained in a three-ring hard back binder. Copies of each submittal shall be three-hole punched and arranged (or folded if required) for the Engineer's filing convenience. Provide one copy of updated TABLE OF CONTENTS and progressive-tabbed index sheets also for the Engineer's filing convenience.

F. Any submittals that do not meet the items listed in sub-section 1.03 D above will be returned without review. The contractor shall be responsible for costs related to additional reviews of items returned without review for cause.

G. Submittal data for each section must be complete. Partial submittals will not be reviewed. To the greatest extent possible all sections shall be submitted with the first submission. No more than three additional submissions will be allowed to complete the submittal package.

H. Mechanical and Plumbing contractor shall be responsible for submitting a coordinated RCP shop drawing showing ALL ceiling mounted devices such as the lights, air devices, fire alarm devices, special systems devices, and sprinkler heads. Drawing shall be submitted to Architect/Engineer for review prior to installation of devices.

I. Unless a greater number is indicated within the Architectural Sections of these specifications, submit six (6) copies of all Brochures for review. Submit one (1) reproducible and one (1) blueprint of shop drawings for review. Comments will be made on the reproducible to facilitate copying. One set will be retained by the Engineer, one (1) set by the Architect for record purposes, and two sets for the Owner's Operating and Maintenance Manuals. Submittals in computerized transmittal in acceptable formats are optional provided the Architect and Engineer have no objection to the contractor's submittal in computer document formats.

J. Minimum size of submittal data shall be 8-1/2 x 11".

K. Any submittal that is disapproved must be resubmitted within two (2) weeks following notification of such disapproval. If no satisfactory material is submitted within the two-week period, the Architect and the Engineer reserves the right to require the Contractor to furnish items exactly as described in the Contract Documents.

L. No allowances will be made for submittals which are not made in a timely fashion or which are turned down because they do not meet the specifications. Should delivery problems arise due to the above, affecting the completion time of the project, the Contractor will furnish and install acceptable alternates until the proper materials arrive and then replace the alternate materials with the approved materials, all at no cost to the Owner. If the Contractor is not able to furnish an acceptable alternate until the proper materials arrive, he will assume all costs for furnishing and installing all alternates as directed by the Architect and/or will pay a suitable penalty for the inconvenience experienced by the Owner. This penalty will be set by the Owner based on the particular circumstances.

M. Only equipment and material brands which are specifically mentioned in the following sections of Division 22 will be considered during the submittal process.

1.5 RECORD DRAWINGS

A. The Contractor shall maintain on a daily basis at the project site a complete set of "Record Drawings", reflecting an accurate dimensional record of all buried or concealed work. The "Record Drawings" shall also consist of a set of blueline or blackline prints of the final "Signed Off" Contractor's Coordination Drawings" prepared by the Subcontractors. In addition, the "Record Drawings" shall be marked to show the precise location of concealed work and equipment, including concealed or embedded piping and valves and all changes and deviations in the Mechanical work from that shown on the Contract Documents. This requirement shall not be construed as authorization for the Contractor to make changes in the layout or work without written definite instructions from the Architect and the Engineer.

B. Daily Record Drawings: The Daily "Record Drawings" shall consist of a set of blueline or blackline prints of the Contract Drawings for this Division with the Engineer's seal and Engineer's firm name removed or blacked out. Final "Record Drawings" shall be electronic CAD files. Prior to commencing work, the Contractor shall purchase from the Architect and the Engineer a set of blueline or blackline prints to be used for the daily "Record Drawings."

C. Final Record Drawings:
   1. Prior to completion of the construction, the Contractor may purchase electronic copies of the floor plans in AutoCAD format for use in developing the Record Drawings from the Engineer if he is the Prime Consultant or from the Architect. If CNG Engineering, PLLC. is the Prime Consultant, these electronic drawings will be made available at a cost of $75.00 per sheet providing an Officer of the Contractor's firm signs a liability release.
   2. Final Record Drawings in AutoCAD format shall comply with the following:
      a. A CADD file that matches the plotted sheet shall be provided to CNG Engineering, this sheet may contain Xreferences linking to the full size design files. The filename of this plotted sheet shall match the sheet number represented in the title block of that sheet.
      b. All CADD files are to be drawn to full size scale, and all elements are to be drawn full size, except where size constraints will not allow the exact dimension, in this case a standard symbol should be used in its place, i.e., an electrical outlet should be a symbolic symbol, whereas a 2'x4' light fixture should be drawn 2'x4'.
      c. Reproducible hardcopy plots shall accompany transfer of electronic media. Verify plotted sheet size with CNG Engineering prior to plotting. Each plotted sheet shall have a corresponding electronic CADD file associated with it.
      d. All CADD design file documents are to be drawn relative to each other with one common origin point universally defined as absolute zero (0,0,0) on a plan view.
      e. The CADD layering scheme shall be such that specific design elements and text can be isolated via layer ON/OFF control. A printed list shall be provided detailing layer name and description of design elements for each layer.
      f. Contractor shall provide to CNG Engineering all non-standard AutoCAD fonts used in the CADD documents. If specialized fonts with characters of ASCII value greater than 126 are used, Contractor shall convert them to graphic lines, circles, arcs, etc. and or blocks, removing the special coded

text string.

g. When X-references are used in the CAD drawings, all support CAD drawings shall remain as X-ref attachments (not bound) to ensure uniformity of layer names, text style names, block names, linetypes names and origin base point. A diagram shall be provided, detailing the exact flow of all X-ref's. Remove all path names from all attached Xref's so that all files can be in one directory and be resolved into AutoCAD.

h. All media shall be accompanied by a printed indexed listing of the contents.

i. If the amount of compressed CAD data exceeds fifty (50) megabytes, contact the CADD/Computer Coordinator at CNG Engineering for further arrangements for transfer of electronic data.

j. Contractor shall provide CAD files and reproducibles of Record Drawings within 15 working days of notification from CNG Engineering, in a form satisfactory as described above.

k. Engineer and/or Owner reserves the right to review CAD files of Record Drawings at any time during construction. If this agreement is terminated, the Contractor shall promptly furnish CAD files as is to that date to CNG Engineering and/or Owner.

D. Record dimensions shall clearly and accurately delineate the work as installed, including horizontal and vertical offsets (with elevations) of underground services. Locations shall be suitably identified by at least two (2) dimensions to permanent structures.

E. The Contractor shall mark all "Record Drawings" on the front lower right hand corner with a rubber stamp impression that states the following:

"RECORD DRAWINGS

(3/8" high letters)

To be used for recording Field Deviations

And Dimensional Data Only."

(5/16" high letters)

F. Upon completion of work, the Contractor shall certify the "Record Drawings" for correctness by signing the following certification:

CERTIFIED CORRECT (3/8" high letters)

(Name of General Contractor

By:_____

Date:_____

(Name of Mechanical, Plumbing, Fire

Protection or Temperature Control Subcontractor)

By:_____

Date:_____

G. Prior to final acceptance of the Work of this Division, the Contractor shall submit properly certified "Record Drawings" to the Architect and the Engineer for review and shall make changes, corrections, or additions as the Architect and the Engineer may require to the "Record Drawings." After the Architect and the Engineer review, one set of reproducible mylars and one (1) set of electronic CAD files (AutoCAD) "Record Drawings" shall be delivered to the Owner.

1.6 RECORD SPECIFICATIONS

A. Maintain and submit Record Specifications as required in Division 01 Specification– CONTRACT CLOSEOUT.

1.7 SPACE LIMITATIONS

A. Equipment has been chosen which will fit into the physical spaces provided and indicated, allowing ample room for access, servicing, removal and replacement of parts, etc. Adequate space shall be allowed for clearance in accordance with the Code requirements and the requirements of the local inspection department.

B. In the preparation of Drawings, a reasonable effort to accommodate approved Equipment Manufacturers' space requirements has been made. However, since space requirements and equipment arrangement vary according to each Manufacturer, the responsibility for initial access and proper fit rests with the Contractor.

C. Physical dimensions and arrangements of equipment to be installed shall be subject to the Architect's review.

D. All mechanical equipment specified herein and shown on the Drawings is schematic. Prior to beginning any work whatsoever, the Division 22 Mechanical Contractor shall

furnish as a part of the mechanical equipment submittals, scaled drawings of all proposed mechanical equipment, indicating accurate sizes and characteristics of proposed equipment, as well as clearances, piping routes, and all other details as required to allow the Engineer, Architect, and Owner the opportunity to approve the proposed layout and equipment. If the arrangement is not acceptable, then the proposed equipment and/or arrangement shall be modified or changed as required to be made acceptable at no additional cost to the Owner.

1.8 CONTRACTOR'S COORDINATION DRAWINGS

A. The Contractor and all Subcontractors shall prepare a complete set of "Coordination Drawings" indicating the equipment actually purchased and the exact routing for all lines such as piping, conduit and ductwork. The elevation, location, support points, load imposed on the structure at support and anchor points, and size of all lines shall be indicated. All beam penetrations and slab penetrations shall be indicated and sized and shall be coordinated. This requirement for "Coordination Drawings" shall not be construed as authorization for the Contractor or Subcontractor to make any unauthorized changes to the Contract Drawings. All Design Drawing space allocations shall be maintained, such as ceiling height, chase walls, equipment room size, etc., unless proper written authorization is received from the Architect to change them.

1.9 OPERATION AND MAINTENANCE MANUAL

A. Prepare and submit to the Architect and the Engineer for delivery to the Owner two (2) sets of an indexed manual with complete technical data for every piece of equipment and material installed under this Contract.
   1. Complete mechanical submittals that were approved for the project.
   2. Manufacturer's installation instruction brochures.
   3. Manufacturer's local representative and/or distributor's name and address.
   4. Manufacturer's operation and maintenance brochures.
   5. Manufacturer's internal wiring diagrams.
   6. Contractor's installation wiring diagrams.
   7. Control system installation Drawings and typed control sequences.
   8. Replacement part number listings and/or descriptions including prices and source of supply.
   9. Lubrication materials required, with instructions.
   10. Valve tag list and schematic diagram.
   11. All warranties and guarantees.
   12. Testing and Balancing Report.
   13. Commissioning Report.
   14. Provide the above item 1 through 13 in separate binders.

B. These manuals shall include all of the listed data bound into permanent hard-back binders identified on the cover with applicable name per list above. Provide a title page listing the name and location of the Building, the Owner, the Architect, the Engineers, the General Contractor, and the Trade-Contractors installing equipment represented in the brochure.

C. Contents of the manual shall be grouped in sections according to the various sections of Division 22 and shall be listed in a Table of Contents.

1.10 QUALITY ASSURANCE

A. Should the Drawings disagree in themselves or with the Specifications or with the various codes and regulations, the better quality or greater quantity of work or materials shall be assumed and estimated, and unless otherwise directed by the Architect and the Engineer in writing, shall be performed or furnished. In case the Specifications should not fully agree with the schedules, the latter shall govern. Figures indicated on Drawings govern scale measurements and large scale details govern small scale Drawings.

B. The Contractor shall comply with all applicable jurisdictional authority requirements including but not limited to city, county, state, or federal rules, codes and ordinances.

C. None of the terms or provisions of this Specification shall be construed as waiving any rules, regulations, or requirements of these authorities.

D. A competent foreman or superintendent, initially approved by the Architect and the Engineer, shall be kept by the Contractor at the building to receive instructions and to act for the Contractor. Once this superintendent has been approved, no change shall be made without approval of the Architect and the Engineer. Owner's representatives shall have the right to observe the work at any time. The Contractor shall have a representative present when his work is being observed, and he shall give assistance, as may be required, to the Architect's and the Engineer's representative. Recommendations made shall be promptly carried out, and all unsatisfactory material and/or workmanship shall be replaced at once, to the satisfaction of the Architect and the Engineer.

E. It shall be the responsibility of the Contractor to consult the Architectural and Engineering Drawings and details so as to thoroughly familiarize himself with the type and quality of construction to be provided on this project.

F. The Plumbing Drawings are diagrammatic in character and cannot show every connection in detail or every pipe and equipment in its exact location. These details are subject to the requirements of codes, ordinances and also electrical, structural and architectural conditions. The Contractor shall carefully investigate all electrical, structural and finish conditions and shall coordinate the separate trades in order to avoid interference between the various phases of work. Work shall be laid out so that it will be concealed in furred chases or above suspended ceilings, etc., in finished portions of the building, unless specifically noted or indicated to be exposed. Work shall be installed to avoid crippling of structural members; therefore, inserts to accommodate hangers shall be set before concrete is poured, and proper openings through floor, walls, beams, etc., shall be provided as hereinafter specified or as otherwise indicated or required before concrete is poured. All work shall be run parallel or perpendicular to the lines of the building unless otherwise noted.

G. The approximate location of each item is indicated on the Drawings. These Drawings are not intended to give complete and exact details in regard to location. Exact locations are to be determined by actual measurements at the building and will in all cases be subject to the approval of the Architect. The Architect and the Engineer reserves the right to make reasonable changes in the locations indicated without additional cost.

1.11 DELIVERY, STORAGE AND HANDLING

A. The Contractor shall not receive material or equipment at the job site until ready for installation or until there is suitable space provided to properly protect equipment from rust, weather, humidity, dust, or physical damage.

1.12 UTILITIES

A. The Contract Documents reflect the general location, size, and elevations of sewer line, location, size and pressure of water and other lines and manner of routing for all utilities known to be required on this project. It shall be the responsibility of the Contractor to visit the site, meet with the local utility companies in order to coordinate and confirm the exact requirements for each utility to provide a complete and operative system. The bid submitted by the Contractor shall include costs for all such coordinative work, as well as any and all utility company charges and/or fees.

1.13 TEMPORARY SERVICES

A. It shall be the responsibility of the Contractor to provide a temporary system for each utility that is required during construction with all such temporary utility costs being billed to the Contractor.

1.14 WARRANTIES AND GUARANTEE

A. The Contractor shall guarantee all materials and workmanship for a period of twelve (12) months after the final acceptance of work.

B. See Division 01 Specification Section – "Product Requirements" for additional requirements regarding warranties.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. The specifications contain the names of manufacturers, which are considered acceptable based on the quality of the product.

B. Where acceptable manufacturers are listed, only products of those manufacturers may be provided. Additionally, the product must meet all the detailed requirements of the specifications.

C. If no manufacturer's name is mentioned, the Contractor shall provide equipment and material which meet the specifications.

D. The Drawings represent the manufacturer's equipment scheduled. The listing of acceptable manufacturers in the specifications is not intended to imply that equipment of these other manufacturers will fit in the space provided or have the same electrical, structural or other requirements as the equipment scheduled. The Contractor must insure that the equipment provided will meet all project requirements prior to submitting data on that equipment.

2.2 MATERIALS AND EQUIPMENT

A. All materials shall be listed, inspected, and approved by the Underwriters Laboratories and shall bear the UL label where labeling service is available. The label or listing of the Underwriters Laboratories, Inc. will be accepted as evidence that the materials or equipment conform to the applicable standards of that agency. In lieu of this listing, the Contractor may submit a statement from a nationally recognized, adequately equipped testing agency, indicating that the items have been treated in accordance with required procedures, and that the materials and equipment comply with all contract requirements.

B. Materials and equipment shall be new and shall be the standard catalog products of manufacturers regularly engaged in the manufacture of products conforming to these Specifications, and shall essentially duplicate materials and equipment that have been in satisfactory use at least two years prior to bid opening. Where custom or special items are required, these shall be fully described using Drawings, material lists, etc., which fully describe in detail the item proposed for use on this project.

C. All metallic materials shall be protected against corrosion. Exposed metallic parts of outdoor apparatus made of ferrous metals but not of corrosion-resistant steel, shall be zinc-coated in accordance with ASTM A123 or A153, except where other equivalent protective treatment is specifically approved in writing.

D. Capacities shall be not less than those indicated but shall be such that no component or system becomes inoperative or is damaged because of start-up or other overload conditions. Where approved equipment requires electrical power other than those used for design purposes, the Contractor shall be responsible to adjust protective devices, starter sizes, conductors, conduits, etc. to accommodate this approved device electrically.

E. Each major component of equipment shall have the manufacturer's name, address, and catalog number on a plate securely attached to the item of equipment. All data on nameplates shall be legible at the time of final inspection.

F. Equipment vibration shall not exceed the following criteria:

Equipment	Maximum Allowable Vibration Peak to Peak Displacement (MIL)
Pumps	
1800 RPM and less	2
3600 RPM and less to 1800	1
Compressors	
Centrifugal	1
Screw	1

Fans (Centrifugal and Axial)

Under 600 RPM	4
600 RPM to 1000 RPM	3
1000 RPM to 2000 RPM	2
Over 2000 RPM	1

G. All pipe, fittings, appurtenances, and other material required for complete installation of these systems shall be new to conform to manufacturer's recommendations, unless otherwise specified. All equipment injured or damaged in transit from factory, during delivery to premises, while in storage on premises, while being erected and installed, and while being tested, until time of final completion, shall be replaced by this Contractor without extra cost to the Owner. Scratched equipment shall be repainted with factory paint to match existing or cold galvanized as required.

H. Surface Burning Characteristics of Materials:
1. Unless specifically noted otherwise, all building and construction materials, adhesives, finishes, etc., shall have a composite assembly fire and smoke hazard rating as tested by Procedure ASTM E84, NFPA 255, and UL 723 not exceeding:
a. Flame Spread: 25.
b. Smoke Developed: 50.
c. Fuel Contribution: 10.

NOTE: Any adhesives, mastics, and cement stored or used on the job site shall have the above fire and smoke hazard rating in the "wet state" in addition to its "dry" rating.

2.3 INSTALLATION

A. All equipment shall be installed in a manner to permit access to parts requiring service without disassembly of piping mains and other equipment. Access panels or doors shall be coordinated with the Architect and the Engineer and provided where necessary to permit valve equipment service or removal. Refer to the architectural specifications for additional requirements.

B. Any large piece of apparatus which is to be installed in any space in the building, and which is too large to permit access through stairways, doorways, or shafts shall be brought to the job and placed in the space before the enclosing structure is completed. Following placement in the space, such apparatus shall be thoroughly and completely protected against damage.

C. This contract includes many different systems furnished and installed by different trades. Each trade shall coordinate their work with that of all other trades so that it may be installed in the most direct and workmanlike manner without hindering or handicapping any other trades. Where space requirements conflict, the following order of precedence shall, in general, be observed:
1. Building lines.
2. Structural members.
3. Soil and drain piping.
4. Vent piping.
5. Refrigerant piping.

6. Condensate piping.
7. Electrical bus duct.
8. Supply ductwork.
9. Exhaust, return, and outside air ductwork.
10. Fire sprinkler piping.
11. Circulating water piping.
12. Domestic hot and cold-water piping.
13. Natural gas piping.
14. Electrical conduit.

D. Minimize installation of water piping in proximity of rooms housing telephone equipment, fire alarm systems, transformers, or other electrical equipment. Do not install water piping within, or above ceilings of these rooms.

2.4 EXCAVATION AND BACKFILL

A. The Contractor shall perform all excavation of every description required in the execution of his work. Excavation shall be through whatever substance encountered, to the depths indicated on the Drawings, or as required. Excavated material suitable for backfill shall be piled in an orderly manner a sufficient distance from the trench to prevent overloading sides and cave-ins. Excavated materials not suitable for backfill shall be removed from the site or stored as directed. Grading shall be done to protect the excavation from surface water. Trenches shall be maintained in a dry condition by bailing, pumping, or other approved methods. Pipe shall not be laid in wet trenches. Sheeting and shoring shall be provided as required for the protection of the work and the safety of personnel.

B. Trenches shall be of the necessary width and depth to provide for proper laying of pipe and appurtenances, with banks as nearly vertical as possible. Bottoms of trenches shall be excavated to the grade and depth indicated or required, and barrel of pipe shall be laid on a minimum 12 inch sand bed. Bell holes, of a size to permit proper make-up of grading, shall be provided as required. For projects located over the Edward's Aquifer Re-Charge Zone, comply with Kendall county Plumbing Code requirements. Existing underground piping shall be protected from damage during excavation and backfilling, and if damaged, shall be repaired to the Architect's and the Engineer's satisfaction, at the Contractor's expense. Provide 3,000 pound concrete of 3 inch minimum enclosure around lines that cross electrical utility lines or telephone cables.

C. Trenches shall not be backfilled until all required tests have been performed. This requirement does not preclude sectional testing and backfilling of the various systems. Trenches shall be carefully backfilled with approved sand, free from large earth clods, rocks, and/or foreign materials, laid in 6 inch layers, moistened thoroughly, and carefully rammed to an elevation of one foot above top of pipe. The remainder of the backfill to finish grade shall be placed in one foot layers soaked with water, and well tamped. Under roadways, backfill to bottom of road bed material with sand only. Where settlement occurs, trenches shall be re-opened to depth required for proper compaction, refilled, and compacted.

D. Open trenches abutting foundation or basement excavations, building walls, and grade beams, will not be permitted, but shall be backfilled and completed, for a distance of not less than 10 feet from the above features, as soon as possible. All damage resulting from flooding or other stresses due to open trenches shall be paid for by the Contractor.

E. Where excavation requires, existing walks, street, drives, or other existing pavement to be cut to install new lines and to make new connections to existing lines, the size of the cut shall be held to a minimum, consistent with the work to be accomplished. After the installation of the new materials is completed and the excavation has been backfilled, the paving shall be patched, using materials to match those cut out. The patches shall be thoroughly bound with the original surfaces and shall be level with them.

2.5 CUTTING AND PATCHING

A. Where it becomes necessary to cut through any wall, floor, or ceiling to permit installation of any work under this section of the Specifications or to repair any defects that may appear, up to the expiration of the guarantee period, such cutting shall be done under the supervision of the Architect and the Engineer by the Contractor. The Contractor shall not be permitted to cut or modify any structural members without the written permission of the Architect and the Engineer.

B. Patching of all openings cut by the Contractor, or repairing of any damage to the work of other trades occasioned by cutting operations, or occasioned by the failure of any part of work installed under this contract, shall be performed by the trade whose work is involved, but shall be paid for by the Contractor.

C. Any openings cut through exterior walls or roofs shall be provided with suitable covers, while they are left open, to protect the property or materials involved. Any openings cut through walls below grade shall be properly protected to prevent entrance of water or other damaging elements.

2.6 FIRE STOP SYSTEMS

A. Seal all pipe, conduit, cables, spare sleeves, etc. penetrations through roofs and fire-rated walls and floors with factory made devices or with manufactured fill, void, or cavity materials classified by Underwriters Laboratories (UL) as a "through-penetration fire stop" and which meet the following requirements:
   1. Maintain the fire resistance rating of the penetrated building construction. Refer to the architectural Contract Documents for fire ratings of general construction.
   2. Comply with the requirements of ASTM E814, UL 1979, ASTM E119, UL 723, ASTM E84 and UL 263 for all types of penetrations sealed.
   3. Do not exhibit excessive shrinkage, which would permit transmission of flame, smoke, gasses, vermin and/or water prior to exposure to a fire condition.
   4. Mastics used to seal surface of fire stop system shall be non-hardening.
   5. Shall accommodate expansion and contraction of the penetrating element, i.e. pipe etc., without reducing its effectiveness as a smoke barrier and/or water seal.

B. Submittal data for fire stop systems shall include applicable UL System numbers.

C. Installing Contractor shall submit evidence that he has been trained by an authorized fire stop system manufacturer's representative prior to beginning the installation. The manufacturer's representative shall visit the jobsite and visually observe representative samples of each of the various fire stop systems employed on this project, during and after installation, and provide a written certification that the installations observed appear to have been installed in accordance with the manufacturer's recommendations and UL requirements.

D. Sealing of conduits that extend through fire-rated walls from ends of cable tray shall be performed after conductors/cables have been installed.

E. Acceptable Manufacturer's Products: If it complies with these Specifications, one of the following manufacturers' fire stop sealing components/systems will be acceptable:
1. 3M Fire Protection Products.
2. General Electric and Specified Technologies, Inc. Spec Seal systems.
3. Nelson Flameseal Fire Stop Putty (dry locations only).
4. Specified Technologies, Inc.
5. Tremco Fire Resistive Joint System utilizing "Dymeric" sealant and Cerablanket-FS mineral filler.

PART 3 - EXECUTION

3.1 HOISTING, SCAFFOLDING, AND TRANSPORTATION

A. The Contractor shall provide his own hoisting facilities and scaffolding to set his materials and equipment in place, as indicated on Drawings and for subsequent cleaning, testing, and adjusting.

B. The Contractor shall provide necessary transportation to facilitate the delivery of all materials, equipment, tools, and labor to the job, in accordance with intent of these documents.

3.2 CLEANING

A. The Contractor shall at all times, keep the premises free from accumulations of waste material or rubbish caused by him, his employees, or his work. This debris shall be removed, not only from the building, but also from the project site.

B. At completion of the job, the Contractor shall remove all of his tools, scaffolding, and surplus materials. He shall leave the area "broom clean."

3.3 ELECTRICAL WIRING OF MOTORS AND EQUIPMENT

A. Unless specifically shown, indicated, or specified to the contrary, each item shown or required by the Mechanical Drawings or specified in the Plumbing Specifications shall be accompanied by all motors and starting and controlling equipment necessary for the items proper operations. These motors shall be integrally attached to and/or installed with their associated equipment item and electrically connected as specified in Division 26 - Electrical. Equipment controlled from motor control centers shall be supplied with motors only. Motor control centers are specified in Division 26 and shown on the Electrical Drawings.

3.4 WORK IN EXISTING BUILDINGS

A. Some of the work to be performed on this project occurs within an existing occupied building. Noisy, dusty, fume emitting and/or other construction operations required for work which may disturb or cause complaints by the building occupants is unacceptable.

B. The Contractor and the Division 22 Subcontractor shall carefully examine the existing building and review all of the Contract Documents prior to submitting his bid in order to

determine the extent of work required to be completed under this Division. Failure to conduct this examination shall not relieve the Contractor of the responsibility to perform all the work required for a complete and fully operational installation satisfactory to the Owner.

C. Contractor shall include in the bid price cost of relocation or removal of existing equipment and systems required for complete installation of the new systems indicated in the Contract Documents. In submitting his bid, the Contractor agrees to accept all existing site conditions not specifically accepted. Where Contract Documents conflict with existing field conditions, a record of the field conditions shall be provided in writing to the Architect.

D. The Contractor shall be responsible for loss or damage to the existing facilities caused by him and his workmen and shall be responsible for repairing or replacing such loss or damage. The Contractor shall send proper notices, make necessary arrangements, and perform other services required for the care, protection, and service and in service maintenance of all plumbing, heating, air conditioning, and ventilating services for the new and existing facilities. The Contractor shall erect temporary barricades, with necessary safety devices, as required to protect personnel from injury, removing all such temporary protection upon completion of the work.

E. All new work shall be coordinated with existing space constraints. All equipment and material shall be fabricated such that complete systems may be disassembled into sections suitable for lifting in the existing freight elevator or construction hoist and fit through existing passageways without unauthorized modifications of the existing building construction.

F. The Contractor shall provide temporary on new services to all existing facilities as required to maintain their proper operation when normal services are disrupted as a result of the work being accomplished under this project.

G. Where existing construction is removed to provide working and extension access to existing utilities, Contractor shall remove doors, piping, conduit, outlet boxes, wiring, light fixtures, air conditioning ductwork and equipment, etc., to provide this access and shall reinstall same upon completion of work in the areas affected.

H. Coordinate new work in existing building in a manner that allows proper phasing of the work with a minimum of disruption of Owner's activities in occupied spaces. All work scheduled in occupied areas MUST BE COORDINATED WITH AND APPROVED BY THE OWNER prior to commencement of the work. Outages of services as required by the new installation will be permitted but only at a time approved by the Owner. The Contractor shall allow the Owner two weeks in order to schedule required outages. The time allowed for outages will not be during normal working hours unless otherwise approved by the Owner. All costs of outages, including overtime charges, shall be included in the contract amount.

I. The Contractor shall use construction methods and materials which shall not adversely affect the indoor air quality of the occupied areas. The contractor shall furnish and install temporary constructions and modify existing air handling system where required to isolate areas under construction from surrounding occupied areas to control the migration of dust or fumes. If deemed necessary by the Owner, the Contractor shall furnish and install temporary supply and/or exhaust fan to negatively pressurize the construction area relative to adjacent occupied areas.

3.5 DEMOLITION AND RELOCATION

A. The Contractor shall modify, remove, and relocate all materials and items so indicated on the Drawings or required by the installation of new facilities. All removals and/or dismantling shall be conducted in a manner as to produce maximum salvage. Salvage materials except asbestos shall remain the property of the Owner and shall be delivered to such destination as directed by the Owner. Non-salvageable materials and equipment shall become the property of the Contractor and removed from the site.

B. Asbestos abatement is being performed by the owner. The Contractor shall immediately notify the Owner of any area where the Contractor suspects or becomes aware of the existence of asbestos or other potentially hazardous materials on this project. It shall be the responsibility of the Contractor to provide written request to the Owner for the services of an Industrial Hygienist who shall provide all necessary testing, analysis and documentation of the status of any areas where asbestos or potentially hazardous materials exist. The Industrial Hygienist shall then prepare plans and specifications which provide for the removal of all potentially hazardous substances and their disposal in a lawful manner. The Contractor shall not remove or disturb asbestos or other potentially hazardous substances until he has obtained approval in writing of the methods, he shall use from the authorities having jurisdiction.

C. All items which are to be relocated shall be carefully removed in reverse to original assembly or placement and protected until relocated. The Contractor shall clean and repair and provide all new materials, fittings, and appurtenances required to complete the relocation and to restore to good operative order. All relocations shall be performed by workmen skilled in the work and in accordance with standard practice of the trades involved. Where items scheduled for relocation and/or reuse are found to be in damaged condition before work has been started on dismantling, the Contractor shall call the attention of the Owner to such items and receive further instructions before removal. Items damaged in repositioning operations are the Contractor's responsibility and shall be repaired or replaced by the Contractor as approved by the Owner, at no additional cost to the Owner or the Architect and the Engineer. The Contractor may, at his discretion, and upon the approval of the Owner, substitute new materials and items of like design and quality in lieu of materials and items to be relocated.

D. Service lines and wiring to items to be removed, salvaged, or relocated shall be removed to points acceptable to the Owner. Service lines and wiring not scheduled for reuse shall be removed to the points at which reuse is to be continued or service is to remain. Such services shall be sealed, capped, or otherwise tied-off or disconnected in a safe manner acceptable to the Owner.

E. Cleanup: It shall be the responsibility of each trade to cooperate fully with the other trades on the job to keep the jobsite in a clean and safe condition. At the end of each day's work, each trade shall properly store all of his tools, equipment and materials and shall clean his debris from the job.

3.6 COMMUNICATIONS AND ELECTRICAL EQUIPMENT ROOMS PRECAUTIONS

A. In general, piping and ductwork shall not be installed in any switchgear, transformer, elevator equipment, telephone, communication or electrical equipment room unless this piping or ductwork serves only that room.

B. Sprinkler heads and piping within main communication equipment rooms and rooms

having electrical gear shall be provided with shields and/or deflectors where required by the AHJ or Owner to protect electrical and/or communications equipment.

C. Piping shall not be installed above switchboards, panelboards, control panels, motor control centers, individual motor controllers etc. Piping shall not be installed above bus duct unless otherwise show on the Drawings.

D. Coordinate with Division 26 Contractor to ensure the above listed precautions requirements are met.

3.7 AUTHORITY HAVING JURISDICTION

A. The "Authority Having Jurisdiction" (AHJ) over the project described by these documents is the Owner/State of Texas/at Kendall County.

B. Where alterations and/or deviations from the Contract Documents, i.e. Drawings and Specifications, are required by the AHJ, report the requirements to the Architect and secure his written approval before starting the alteration.

C. Modifications to the Division 23 work required by the AHJ shall be made by the Contractor without additional cost to the Owner.

3.8 CODES AND REFERENCE STANDARDS

A. All materials and workmanship shall comply with the requirements of the Building, Mechanical, Electrical, Plumbing, Fire, Accessibility, and Energy Codes adopted by the Authority Having Jurisdiction, including all amendments, applicable laws and ordinances and supplementary rules and interpretations. Where Contract Document requirements exceed Code requirements and are permitted under the Code, the Contract Documents shall govern.

B. In all cases where Underwriter's Laboratories, Inc. have established standards for a particular type material, such material shall comply with these standards or other nationally recognized testing standards acceptable to the Authority Having Jurisdiction. Evidence of compliance shall be the UL "label" or "listing" under Re-Examination Service.

C. The following specific codes and standards shall apply to this project:
1. ADA Accessibility Guidelines for Buildings and Facilities, 1991 (ADAAG) with current amendments.
2. Americans with Disabilities Act, Part III, 28 CFR 36, July 26, 1991 (ADA).
3. Building Services Piping (ASME/ANSI B31.9).
4. Elimination of Architectural Barriers Act, Texas Department of Licensing and Regulations, Texas Civil Statutes, Article 9102,
5. Energy Conservation Standard for New State Buildings.
6. Governing Fire Department requirements.
7. National Fire Codes (NFPA), current edition.
8. National Electrical Code (NFPA 70), latest edition.
9. Occupational Safety and Health Act (OSHA).
10. Safety Code for Elevators and Escalators (ASME A17.1), 19__ edition.
11. Standards for Access to the Handicapped (ANSI 117.1).
12. Texas Accessibility Standards (TAS), Texas Department of Licensing and Regulations (TDLR), Architectural Barriers Act, Article 9102, Texas Civil Statutes, effective April 1, 1994.

13. Texas Boiler Law, Chapter 755, Health and Safety Code, Texas Department of Licensing and Regulations.
14. 2006 International Building code with local amendments.
15. 2006 International Mechanical code with local amendments.
16. 2006 International Fire code with local amendments.
17. 2000 International Energy conservation code with local amendments.
18. 2006 Uniform Plumbing code with local amendments.
19. 2005 National Electric code with local amendments.
20. 2001 Supplemental with local amendments.

D. Refer to Division 01 and the Division 22 Specification Sections hereinafter bound for additional applicable regulatory requirements.

3.9 OWNER'S RULES AND REGULATIONS

A. Comply with Owner's rules and regulations as they apply.

3.10 DISCREPANCIES

A. The Contract Documents are intended to comply with the aforementioned rules and regulations; however, some discrepancies may occur. Where such discrepancies occur, the Contractor shall immediately notify the Architect and the Engineer in writing of said discrepancies and apply for an interpretation.

B. Should the discovery and notification occur after the execution of the Contract, any additional work required for compliance with said regulations shall be paid for as covered by applicable Division, providing no work or fabrication of materials has been accomplished in a manner of noncompliance.

C. Should the Contractor fabricate and/or install materials and/or workmanship in such a manner that does not comply with the applicable codes, rules and regulations, the Contractor who performed such work shall bear all costs arising in correcting these deficiencies to comply with said rules and regulations.

END OF SECTION 220510

SECTION 220513 - COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.3 COORDINATION

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

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with NEMA MG 1 unless otherwise indicated.

B. Comply with IEEE 841 for severe-duty motors.

2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Energy efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Multispeed Motors: Variable torque.

1. For motors with 2:1 speed ratio, consequent pole, single winding.
2. For motors with other than 2:1 speed ratio, separate winding for each speed.

E. Multispeed Motors: Separate winding for each speed.

F. Rotor: Random-wound, squirrel cage.

G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

H. Temperature Rise: Match insulation rating.

I. Insulation: Class F.

J. Code Letter Designation:
1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.

K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

C. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.5 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
1. Permanent-split capacitor.
2. Split phase.
3. Capacitor start, inductor run.
4. Capacitor start, capacitor run.

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

C. Bearings: Pre-lubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type.

E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 220513

SECTION 220517 - SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Sleeves.
2. Stack-sleeve fittings.
3. Sleeve-seal systems.
4. Sleeve-seal fittings.
5. Grout.

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/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.

C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, 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:
1. Smith, Jay R. Mfg. Co.
2. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.

B. 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:
   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 [NBR] 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] [Plastic] [Stainless steel].
   3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, [Stainless steel] of length required to secure pressure plates to sealing elements.

2.4 SLEEVE-SEAL FITTINGS

A. Manufacturers:
   1. Presealed Systems.

B. 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 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 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] [Galvanized-steel wall sleeves] [Galvanized-steel-pipe sleeves] [Sleeve-seal fittings].
      b. Piping NPS 6 and Larger: [Cast-iron wall sleeves] [Galvanized-steel wall sleeves] [Galvanized-steel-pipe sleeves].
   2. Exterior Concrete Walls below Grade:
      a. Piping Smaller Than NPS 6: [Cast-iron wall sleeves with sleeve-seal system] [Galvanized-steel wall sleeves with sleeve-seal system] [Galvanized-steel-pipe sleeves with sleeve-seal system] [Sleeve-seal fittings].
         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] [Galvanized-steel wall sleeves with sleeve-seal system] [Galvanized-steel-pipe sleeves with sleeve-seal system].
         1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
   3. Concrete Slabs-on-Grade:
      a. Piping Smaller Than NPS 6: [Cast-iron wall sleeves with sleeve-seal system] [Galvanized-steel wall sleeves with sleeve-seal system] [Galvanized-steel-pipe sleeves with sleeve-seal system] [Sleeve-seal fittings].
         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] [Galvanized-steel wall sleeves with sleeve-seal system] [Galvanized-steel-pipe sleeves with sleeve-seal system] [Galvanized-steel-pipe sleeves].
         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] [PVC-pipe sleeves] [Stack-sleeve fittings] [Sleeve-seal fittings] [Molded-PE or -PP sleeves] [Molded-PVC sleeves].
      b. Piping NPS 6 and Larger: [Galvanized-steel-pipe sleeves] [PVC-pipe sleeves] [Stack-sleeve fittings].
   5. Interior Partitions:

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

END OF SECTION 220517

SECTION 220517 - SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Sleeves.
   2. Stack-sleeve fittings.
   3. Sleeve-seal systems.
   4. Sleeve-seal fittings.
   5. Grout.

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/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.
C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, 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:
   1. Smith, Jay R. Mfg. Co.
   2. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.
B. 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:
   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: Carbon steel.

3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.4 SLEEVE-SEAL FITTINGS

A. Manufacturers:
   1. Presealed Systems.
B. 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 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 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: Sleeve-seal fittings
   b. Piping NPS 6 and Larger: Galvanized-steel wall sleeves.
2. Exterior Concrete Walls below Grade:
   a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves with sleeve-seal system.
      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
   b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves with sleeve-seal system.
      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
3. Concrete Slabs-on-Grade and above Grade:
   a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves with sleeve-seal system.
      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
   b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves with sleeve-seal system.
      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
4. Interior Partitions:
   a. Piping Smaller Than NPS 6: PVC-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.
   2. Floor plates.

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 [and] [rough-brass] finish and setscrew fastener.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.

C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.

D. Split-Casting Brass Type: With polished, chrome-plated [and] [rough-brass] finish and with concealed hinge and setscrew.

E. Split-Plate, Stamped-Steel Type: With chrome-plated finish, [concealed] [and] [exposed-rivet] hinge, and spring-clip fasteners.

2.2 FLOOR PLATES

A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

B. Split-Casting Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

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

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of 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.
      b. Chrome-Plated Piping: One-piece, cast-brass[or split-casting brass] type with polished, chrome-plated finish.
      c. Insulated Piping: One-piece, stamped-steel type[or split-plate, stamped-steel type with concealed hinge] [or split-plate, stamped-steel type with exposed-rivet hinge].
      d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass[or split-casting brass] type with polished, chrome-plated finish.
      e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type[or split-plate, stamped-steel type with concealed hinge] [or split-plate, stamped-steel type with exposed-rivet hinge].
      f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass[or split-casting brass] type with polished, chrome-plated finish.
      g. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type[or split-plate, stamped-steel type with concealed hinge] [or split-plate, stamped-steel type with exposed-rivet hinge].
      h. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass[or split-casting brass] type with [polished, chrome-plated] [rough-brass] finish.
      i. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type[or split-plate, stamped-steel type with concealed hinge] [or split-plate, stamped-steel type with exposed-rivet hinge].
      j. Bare Piping in Equipment Rooms: One-piece, cast-brass[or split-casting brass] type with [polished, chrome-plated] [rough-brass] finish.
      k. Bare Piping in Equipment Rooms: One-piece, stamped-steel type[or split-plate, stamped-steel type with concealed hinge] [or split-plate, stamped-steel type with exposed-rivet hinge].
   2. Escutcheons for Existing Piping:
      a. Chrome-Plated Piping: Split-casting brass type with polished, chrome-plated finish.
      b. Insulated Piping: Split-plate, stamped-steel type with [concealed] [or] [exposed-rivet] hinge.
      c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
      d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped-steel type with [concealed] [or] [exposed-rivet] hinge.
      e. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
      f. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped-steel type with [concealed] [or] [exposed-rivet] hinge.
      g. Bare Piping in Unfinished Service Spaces: Split-casting brass type with [polished, chrome-plated] [rough-brass] finish.
      h. Bare Piping in Unfinished Service Spaces: Split-plate, stamped-steel type with [concealed] [or] [exposed-rivet] hinge.
      i. Bare Piping in Equipment Rooms: Split-casting brass type with [polished, chrome-plated] [rough-brass] finish.
      j. Bare Piping in Equipment Rooms: Split-plate, stamped-steel type with [concealed] [or] [exposed-rivet] hinge.

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

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
   1. New Piping: One-piece, floor-plate type.
   2. Existing Piping: Split-casting, floor-plate type.

3.2 FIELD QUALITY CONTROL

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

END OF SECTION 220518

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.
  2. Floor plates.

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.
- D. Split-Casting Brass Type: With polished, chrome-plated finish and with concealed hinge and setscrew.
- E. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed hinge, and spring-clip fasteners.

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

PART 3 - EXECUTION

3.1 INSTALLATION
- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of 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.
     b. Chrome-Plated Piping: One-piece, cast-brass type with polished, chrome-plated finish.
     c. Insulated Piping: One-piece, stamped-steel type type with exposed-rivet hinge].
     d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
     e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
     f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
     g. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.
     h. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
     i. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type.
     j. Bare Piping in Equipment Rooms: One-piece, cast-brass type with polished, chrome-plated finish.

k. Bare Piping in Equipment Rooms: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.

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

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
   1. New Piping: One-piece, floor-plate type.
   2. Existing Piping: Split-casting, floor-plate type.

3.2 FIELD QUALITY CONTROL

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

END OF SECTION 220518

SECTION 220519 - METERS AND GAUGES 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. Bimetallic-actuated thermometers.
   2. Filled-system thermometers.
   3. Liquid-in-glass thermometers.
   4. Thermowells.
   5. Dial-type pressure gauges.
   6. Gauge attachments.
   7. Test plugs.
   8. Test-plug kits.
   9. Sight flow indicators.

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

1.3 SUBMITTALS

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

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

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

PART 2 - PRODUCTS

2.1 BIMETALLIC-ACTUATED THERMOMETERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, 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 3-inch 76-mm nominal diameter.

D. Dial: Nonreflective aluminum with permanently etched scale markings and scales in deg F.
E. Connector Type(s): Union joint, angle rigid, back and rigid, bottom, with unified-inch screw threads.
F. Connector Size: 1/2 inch, with ASME B1.1 screw threads.
G. Stem: 0.25 or 0.375 inch in diameter; stainless steel.
H. Window: Plain glass 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 FILLED-SYSTEM THERMOMETERS

A. Direct-Mounted, Metal-Case, Vapor-Actuated Thermometers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Ashcroft Inc.
b. Marsh Bellofram.
c. Miljoco Corporation.
d. Palmer Wahl Instrumentation Group.
e. REOTEMP Instrument Corporation.
f. Trerice, H. O. Co.
g. Weiss Instruments, Inc.
2. Standard: ASME B40.200.
3. Case: Sealed type, cast aluminum or drawn steel 4-1/2-inch nominal diameter.
4. Element: Bourdon tube or other type of pressure element.
5. Movement: Mechanical, dampening type, with link to pressure element and connection to pointer.
6. Dial: Non reflective aluminum with permanently etched scale markings graduated in deg F.
7. Pointer: Dark-colored metal.
8. Window: Glass or plastic Insert material.
9. Ring: Metal Stainless steel.
10. Connector Type(s): Union joint, adjustable, 180 degrees in vertical plane, with ASME B1.1 screw threads.
11. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.
a. Design for Thermo well Installation: Bare stem.
12. Accuracy: Plus or minus 1 percent of scale range.

B. Direct-Mounted, Plastic-Case, Vapor-Actuated Thermometers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Ashcroft Inc.
b. Miljoco Corporation.
c. REOTEMP Instrument Corporation.
2. Standard: ASME B40.200.
3. Case: Sealed type, plastic; 4-1/2-inch nominal diameter.
4. Element: Bourdon tube or other type of pressure element.
5. Movement: Mechanical, with link to pressure element and connection to pointer.

6. Dial: Non reflective aluminum with permanently etched scale markings graduated in deg F.
7. Pointer: Dark-colored metal.
8. Window: Glass or plastic.
9. Ring: Metal.
10. Connector Type(s): Union joint, adjustable, 180 degrees in vertical plane, 360; with ASME B1.1 screw threads.
11. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.
    a. Design for Thermo well Installation: Bare stem.
12. Accuracy: Plus or minus 1 percent of scale range.

C. Remote-Mounted, Plastic-Case, Vapor-Actuated Thermometers:
1. 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 CSA.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

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

2.4 PRESSURE GAUGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gauges:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    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 Sealed Solid-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 NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
8. Pointer: Dark-colored metal.
9. Window: Glass.
10. Ring: Metal.
11. Accuracy: Grade B, plus or minus 2 percent of middle half of scale range.

2.5 GAUGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2 ASME B1.20.1 pipe threads and piston porous-metal-type surge-dampening device. Include extension for use on insulated piping.
B. Valves: Brass ball Brass or stainless-steel needle, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install thermowells with socket extending one-third of pipe diameter and in vertical position in piping tees.
B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
C. Install thermowells with extension on insulated piping.
D. Fill thermowells with heat-transfer medium.
E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.
G. Install direct-mounted pressure gauges in piping tees with pressure gauge located on pipe at the most readable position.
H. Install remote-mounted pressure gauges on panel.
I. Install valve and snubbed in piping for each pressure gauge for fluids.
J. Install test plugs in piping tees.
K. Install thermometers in the following locations:
    1. Inlet and outlet of each water heater.
L. Install pressure gauges in the following locations:
    1. Inlet and outlet of each pump.

3.2 CONNECTIONS

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

3.3 ADJUSTING

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

3.4 THERMOMETER SCHEDULE

A. Thermometers at inlet and outlet of each domestic water heater shall be one of the following:
   1. Sealed bimetallic-actuated type.
B. Thermometer stems shall be of length to match thermowell insertion length.

3.5 THERMOMETER SCALE-RANGE SCHEDULE

A. Scale Range for Domestic Cold-Water Piping: 0 to 100 deg F and minus 20 to plus 50 deg C.
B. Scale Range for Domestic Hot-Water Piping: 0 to 250 deg F and 0 to 150 deg C.

3.6 PRESSURE-GAUGE SCHEDULE

A. Pressure gauges at suction and discharge of each water pump shall be one of the following:
   1. Sealed, direct mounted, metal case.

3.7 PRESSURE-GAUGE SCALE-RANGE SCHEDULE

A. Scale Range for Water Service Piping: 0 to 160 psi.

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. Brass ball valves.
2. Bronze ball valves.
3. Iron ball valves.
4. Bronze lift checks valves.
5. Bronze swing checks valves.
6. Iron swing check valves.
7. Iron swing check valves with closure control.
8. Iron, grooved-end swing checks valves.
9. Iron, center-guided check valves.
10. Iron, plate-type check valves.
11. Bronze gate valves.
12. Iron Gate valves.
13. Lubricated plug valves.

B. Related Sections:
1. Division 22 plumbing piping Sections for specialty valves applicable to those Sections only.
2. Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.
3. Section 220500 "Common Work Results for Plumbing".

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: No rising 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 utilized.

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 and gate valves closed to prevent rattling.
4. Set ball and plug valves open to minimize exposure of functional surfaces.
5. 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 hand wheels 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. Hand wheel: For valves other than quarter-turn types.
2. Hand lever: For quarter-turn valves NPS 6 and smaller except plug valves.
3. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 10 plug valves, for each size square plug-valve head.

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

F. Valve-End Connections:
1. Flanged: With flanges according to ASME B16.1 for iron valves.
2. Grooved: With grooves according to AWWA C606.
3. Solder Joint: With sockets according to ASME B16.18.
4. Threaded: With threads according to ASME B1.20.1.

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

2.2 BRASS BALL VALVES

A. Two-Piece, Full-Port, Brass Ball Valves with Stainless-Steel Trim:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Jomar International, LTD.
b. Kitz Corporation.
c. Marwin Valve; a division of Richards Industries.
d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
e. Apollo.
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: Forged brass.
f. Ends: Threaded.
g. Seats: PTFE or TFE.
h. Stem: Stainless steel.
i. Ball: Stainless steel, vented.
j. Port: Full.

2.3 BRONZE BALL VALVES

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

2.4 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 available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Crane Co.; Crane Valve Group; Stockham Division.
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.

B. Class 125, Lift Check Valves with Nonmetallic Disc:
1. Description:
a. Standard: MSS SP-80, Type 2.
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: NBR, PTFE, or TFE.

2.5 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 available manufacturers offering products that may be incorporated into the Work include, but are not limited to, 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 125, Bronze Swing Check Valves with Nonmetallic Disc:

2.6 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 available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. NIBCO INC.
   2. Description:
      a. Standard: MSS SP-71, Type I.
      b. 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.

2.7 IRON, CENTER-GUIDED CHECK VALVES

A. Class 125, Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Anvil International, Inc.
      b. APCO Willamette Valve and Primer Corporation.
      c. Crispin Valve.
      d. DFT Inc.
      e. Flo Fab Inc.
      f. GA Industries, Inc.
      g. Hammond Valve.
      h. Metraflex, Inc.
      i. Milwaukee Valve Company.
      j. Mueller Steam Specialty; a division of SPX Corporation.
      k. NIBCO INC.
      l. Spence Strainers International; a division of CIRCOR International, Inc.
      m. Sure Flow Equipment Inc.
      n. Val-Matic Valve & Manufacturing Corp.
      o. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   2. Description:
      a. Standard: MSS SP-125.
      b. CWP Rating: 200 psig.
      c. Body Material: ASTM A 126, gray iron.
      d. Style: Compact wafer.
      e. Seat: Bronze.

2.8 BRONZE GATE VALVES

A. Class 125, NRS Bronze Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   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 1.
   b. CWP Rating: 200 psig.
   c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
   d. Ends: Threaded r solder joint.
   e. Stem: Bronze.
   f. Disc: Solid wedge; bronze.
   g. Packing: Asbestos free.
   h. Hand heel: Malleable iron, bronze, or aluminum.

B. Class 125, RS Bronze Gate Valves:
1. Manufacturers: Subject to compliance with requirements, ,provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   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. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   k. Zy-Tech Global Industries, Inc.
2. Description:
   a. Standard: MSS SP-80, Type 2.
   b. CWP Rating: 200 psig.
   c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
   d. Ends: Threaded or solder joint.
   e. Stem: Bronze.
   f. Disc: Solid wedge; bronze.
   g. Packing: Asbestos free.
   h. Hand wheel: Malleable iron, bronze, or aluminum.

C. Class 150, NRS Bronze Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Hammond Valve.
   b. Kitz Corporation.
   c. Milwaukee Valve Company.
   d. NIBCO INC.
   e. Powell Valves.
   f. Red-White Valve Corporation.
   g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
   a. Standard: MSS SP-80, Type 1.
   b. CWP Rating: 300 psig.
   c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
   d. Ends: Threaded.
   e. Stem: Bronze.
   f. Disc: Solid wedge; bronze.
   g. Packing: Asbestos free.
   h. Hand wheel: Malleable iron, bronze, or aluminum.

D. Class 150, RS Bronze Gate Valves:
1. Manufacturers: Subject to compliance with requirements, ,provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   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. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   i. Zy-Tech Global Industries, Inc.
2. Description:
   a. Standard: MSS SP-80, Type 2.
   b. CWP Rating: 300 psig.
   c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
   d. Ends: Threaded.
   e. Stem: Bronze.
   f. Disc: Solid wedge; bronze.
   g. Packing: Asbestos free.
   h. Hand wheel: Malleable iron, bronze, or aluminum.

2.9 IRON GATE VALVES

A. Class 125, NRS, Iron Gate Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   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. Flo Fab Inc.
e. Hammond Valve.
f. Kitz Corporation.
g. Legend Valve.
h. Milwaukee Valve Company.
i. NIBCO INC.
j. Powell Valves.
k. Red-White Valve Corporation.
l. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
m. Zy-Tech Global Industries, Inc.

2. Description:
a. Standard: MSS SP-70, 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. Disc: Solid wedge.
g. Packing and Gasket: Asbestos free.

B. Class 125, OS&Y, Iron Gate Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
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. Flo Fab Inc.
e. Hammond Valve.
f. Kitz Corporation.
g. Legend Valve.
h. Milwaukee Valve Company.
i. NIBCO INC.
j. Powell Valves.
k. Red-White Valve Corporation.
l. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
m. Zy-Tech Global Industries, Inc.
2. Description:
a. Standard: MSS SP-70, 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. Disc: Solid wedge.
g. Packing and Gasket: Asbestos free.

2.10 LUBRICATED PLUG VALVES

A. Class 125, Regular-Gland, Lubricated Plug Valves with Threaded Ends:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Nordstrom Valves, Inc.
2. Description:
   a. Standard: MSS SP-78, Type II.
   b. CWP Rating: 200 psig.
   c. Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
   d. Pattern: Regular or short Venturi.
   e. Plug: Cast iron or bronze with sealant groove.

B. Class 125, Regular-Gland, Lubricated Plug Valves with Flanged Ends:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Nordstrom Valves, Inc.
2. Description:
   a. Standard: MSS SP-78, Type II.
   b. CWP Rating: 200 psig.
   c. Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
   d. Pattern: Regular or short Venturi.
   e. Plug: Cast iron or bronze with sealant groove.

C. Class 125, Cylindrical, Lubricated Plug Valves with Threaded Ends:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Homestead Valve; a division of Olson Technologies, Inc.
   b. Milliken Valve Company.
   c. R & M Energy Systems; a unit of Robbins & Myers, Inc.
2. Description:
   a. Standard: MSS SP-78, Type IV.
   b. CWP Rating: 200 psig.
   c. Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
   d. Pattern: Regular or short.
   e. Plug: Cast iron or bronze with sealant groove.

D. Class 125, Cylindrical, Lubricated Plug Valves with Flanged Ends:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Homestead Valve; a division of Olson Technologies, Inc.
   b. Milliken Valve Company.
   c. R & M Energy Systems; a unit of Robbins & Myers, Inc.
2. Description:
   a. Standard: MSS SP-78, Type IV.
   b. CWP Rating: 200 psig. .
   c. Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.

d. Pattern: Regular or short Venturi.
e. Plug: Cast iron or bronze with sealant groove.

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

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

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

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

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

D. Install check valves for proper direction of flow and as follows:
1. Swing Check Valves: In horizontal position with hinge pin level.
2. Center-Guided and Plate-Type Check Valves: In horizontal or vertical position, between flanges.
3. Lift Check Valves: With stem upright and plumb.

3.4 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.

3.5 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:
1. Shutoff Service: Ball, butterfly valves.
2. Throttling Service: Ball Valves.
3. 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.

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.

3.6 DOMEST`IC, HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2" and Smaller:
1. Bronze and Brass Valves: Threaded ends.
2. Bronze Angle Valves: Class 125, Class 150 bronze disc.
3. Ball Valves: Two piece, full port, brass or bronze with stainless-steel trim.
4. Bronze Swing Check Valves: Class 125 bronze discs.
5. Bronze Gate Valves: Class 125 , NRS RS
6. Bronze Globe Valves: Class 125 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 Ball Valves: Class 150.
3. Iron Swing Check Valves: Class 125 metal seats.
4. Iron Swing Check Valves with Closure Control: Class 125, lever and spring.
5. Iron, Grooved-End Swing Check Valves: 300 CWP.
6. Iron, Center-Guided Check Valves: Class 125 compact-wafer, metal seat.
7. Iron, Plate-Type Check Valves: Class 125 dual plate; metal seat.
8. Iron Gate Valves: Class 125 NRS OS&Y.

END OF SECTION 220523

SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Fiberglass pipe hangers.
4. Metal framing systems.
5. Fiberglass strut systems.
6. Thermal-hanger shield inserts.
7. Fastener systems.
8. Pipe stands.
9. Pipe positioning systems.
10. Equipment supports.

B. Related Sections:
1. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Section 220516 "Expansion Fittings and Loops for Plumbing Piping" for pipe guides and anchors.
3. Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment" for vibration isolation devices.

1.3 DEFINITIONS

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

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to [ASCE/SEI 7] <Insert requirement>.
1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
3. Design seismic-restraint hangers and supports for piping and equipment[and obtain approval from authorities having jurisdiction].

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.
   3. Fiberglass strut systems.
   4. Pipe stands.
   5. Equipment supports.

C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   1. Detail fabrication and assembly of trapeze hangers.
   2. Design Calculations: Calculate requirements for designing trapeze hangers.

1.6 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.7 QUALITY ASSURANCE

A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:
   1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
   2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
   3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
   4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
   5. Hanger Rods: Continuous-thread rod, nuts, and washer made of [carbon steel] [stainless steel] <Insert material>.

B. Stainless-Steel Pipe Hangers and Supports:
   1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
   2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
   3. Hanger Rods: Continuous-thread rod, nuts, and washer made of [stainless steel] <Insert material>.

C. Copper Pipe Hangers:
   1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
   2. Hanger Rods: Continuous-thread rod, nuts, and washer made of [copper-coated steel] [stainless steel] <Insert material>.

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 FIBERGLASS PIPE HANGERS

A. Clevis-Type, Fiberglass Pipe Hangers:
   1. Description: Similar to MSS SP-58, Type 1, steel pipe hanger except hanger is made of fiberglass or fiberglass-reinforced resin.
   2. Hanger Rods: Continuous-thread rod, washer, and nuts made of [fiberglass] [polyurethane] [or] [stainless steel] <Insert material>.

B. Strap-Type, Fiberglass Pipe Hangers:
   1. Description: Similar to MSS SP-58, Type 9 or Type 10, steel pipe hanger except hanger is made of fiberglass-reinforced resin.
   2. Hanger Rod and Fittings: Continuous-thread rod, washer, and nuts made of [stainless steel] <Insert material>.

2.4 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:
   1. Manufacturers: Subject to compliance with requirements, [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
   2. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
      a. Allied Tube & Conduit.
      b. Cooper B-Line, Inc.
      c. Flex-Strut Inc.
      d. GS Metals Corp.
      e. Thomas & Betts Corporation.
      f. Unistrut Corporation; Tyco International, Ltd.
      g. Wesanco, Inc.
   3. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
   4. Standard: MFMA-4.
   5. Channels: Continuous slotted steel channel with inturned lips.
   6. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
   7. Hanger Rods: Continuous-thread rod, nuts, and washer made of [carbon steel] [stainless steel] <Insert material>.

8. Metallic Coating: [Electroplated zinc] [Hot-dipped galvanized] [Mill galvanized] [In-line, hot galvanized] [Mechanically-deposited zinc].
9. Paint Coating: [Vinyl] [Vinyl alkyd] [Epoxy] [Polyester] [Acrylic] [Amine] [Alkyd] <Insert paint type>.
10. Plastic Coating: [PVC] [Polyurethane] [Epoxy] [Polyester] <Insert plastic type>.
11. Combination Coating: <Insert coating materials in order of application>.

B. Non-MFMA Manufacturer Metal Framing Systems:
1. Manufacturers: Subject to compliance with requirements, [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
2. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer's name; product name or designation> or comparable product 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; H-Strut Division.
   e. NIBCO INC.
   f. PHD Manufacturing, Inc.
   g. PHS Industries, Inc.
3. Description: Shop- or field-fabricated pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
4. Standard: Comply with MFMA-4.
5. Channels: Continuous slotted steel channel with inturned lips.
6. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
7. Hanger Rods: Continuous-thread rod, nuts, and washer made of [carbon steel] [stainless steel] <Insert material>.
8. Coating: [Zinc] [Paint] [PVC] <Insert coating>.

2.5 FIBERGLASS STRUT SYSTEMS

A. Manufacturers: Subject to compliance with requirements, [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

B. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
1. Allied Tube & Conduit.
2. Champion Fiberglass, Inc.
3. Cooper B-Line, Inc.
4. SEASAFE, INC.; a Gibraltar Industries Company.

C. Description: Shop- or field-fabricated pipe-support assembly similar to MFMA-4 for supporting multiple parallel pipes.
1. Channels: Continuous slotted fiberglass[or other plastic] channel with inturned lips.
2. Channel Nuts: Fiberglass nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.

3. Hanger Rods: Continuous-thread rod, nuts, and washer made of [fiberglass] [stainless steel] <Insert material>.

2.6 THERMAL-HANGER SHIELD INSERTS

A. Manufacturers: Subject to compliance with requirements, [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

B. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
1. Carpenter & Paterson, Inc.
2. Clement Support Services.
3. ERICO International Corporation.
4. National Pipe Hanger Corporation.
5. PHS Industries, Inc.
6. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
7. Piping Technology & Products, Inc.
8. Rilco Manufacturing Co., Inc.
9. Value Engineered Products, Inc.

C. Insulation-Insert Material for Cold Piping: [ASTM C 552, Type II cellular glass with 100-psig] [or] [ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig] minimum compressive strength and vapor barrier.

D. Insulation-Insert Material for Hot Piping: [Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig] [ASTM C 552, Type II cellular glass with 100-psig] [or] [ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig] minimum compressive strength.

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 (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

2.7 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type, [zinc-coated] [stainless-] steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.8 PIPE STANDS

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

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

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

D. High-Type, Single-Pipe Stand:
1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
2. Base: [Plastic] [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:
1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
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 supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.9 PIPE POSITIONING SYSTEMS

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

2.10 EQUIPMENT SUPPORTS

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

2.11 MISCELLANEOUS MATERIALS

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

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

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

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
   1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
   2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Fiberglass Pipe-Hanger Installation: Comply with applicable portions of MSS SP-69 and MSS SP-89. Install hangers and attachments as required to properly support piping from building structure.

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

E. Fiberglass Strut System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled fiberglass struts.

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

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

H. Pipe Stand Installation:
   1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
   2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 077200 "Roof Accessories" for curbs.

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

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

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

L. 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.

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

N. 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] <Insert size> 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.

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

P. 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.

Q. 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 EQUIPMENT SUPPORTS

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

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

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

3.3 METAL FABRICATIONS

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

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

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

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

B. Trim excess length of continuous-thread hanger and support rods to [1-1/2 inches] <Insert dimension>.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils .

B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in [Section 099113 "Exterior Painting."] [Section 099123 "Interior Painting."] [Section 099600 "High-Performance Coatings."]

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

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

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

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

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

E. Use carbon-steel [pipe hangers and supports] [metal trapeze pipe hangers] [and] [metal framing systems] and attachments for general service applications.

F. Use [stainless-steel pipe hangers] [and] [fiberglass pipe hangers] [and] [fiberglass strut systems] and [stainless-steel] [or] [corrosion-resistant] attachments for hostile environment applications.

G. Use copper-plated pipe hangers and [copper] [or] [stainless-steel] attachments for copper piping and tubing.

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

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

J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
   2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
   3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
   4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
   5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
   6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
   7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
   8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
   9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
   10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
   11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
   12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
   13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
   14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
   15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.

16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is 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.

K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

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

M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.

9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
    a. Light (MSS Type 31): 750 lb.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.
13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

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

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

Q. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

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

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

END OF SECTION 220529

SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Metal pipe hangers and supports.
   2. Trapeze pipe hangers.
   3. Fiberglass strut systems.
   4. Thermal-hanger shield inserts.
   5. Fastener systems.
   6. Pipe stands.
   7. Pipe positioning systems.
   8. Equipment supports.

B. Related Sections:
   1. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
   2. Section 220516 "Expansion Fittings and Loops for Plumbing Piping" for pipe guides and anchors.
   3. Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment" for vibration isolation devices.

1.3 DEFINITIONS

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

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to [ASCE/SEI 7] <Insert requirement>.
   1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
   2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
   3. Design seismic-restraint hangers and supports for piping and equipment[and obtain approval from authorities having jurisdiction].

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. Pipe stands.
   3. Equipment supports.

C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   1. Detail fabrication and assembly of trapeze hangers.
   2. Design Calculations: Calculate requirements for designing trapeze hangers.

1.6 INFORMATIONAL SUBMITTALS
A. Welding certificates.

1.7 QUALITY ASSURANCE
A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS
A. Carbon-Steel Pipe Hangers and Supports:
1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pre galvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel
B. Stainless-Steel Pipe Hangers and Supports:
1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.
C. Copper Pipe Hangers:
1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

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

2.3 THERMAL-HANGER SHIELD INSERTS
A. Manufacturers:
1. Carpenter & Paterson, Inc.
2. Clement Support Services.
3. ERICO International Corporation.
4. National Pipe Hanger Corporation.
5. PHS Industries, Inc.
6. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
7. Piping Technology & Products, Inc.
8. Rilco Manufacturing Co., Inc.
9. Value Engineered Products, Inc.
B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength and vapor barrier.
C. Insulation-Insert Material for Hot Piping: ASTM C 552, Type II cellular glass with 100-psigminimum compressive strength.
D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
F. Insert Length: Extend 2 inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

2.4 FASTENER SYSTEMS
A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type, [zinc-coated] [stainless-] steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.5 PIPE STANDS

A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support 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.
C. Low-Type, Single-Pipe Stand: One-piece [plastic] [stainless-steel] base unit with plastic roller, for roof installation without membrane penetration.
D. High-Type, Single-Pipe Stand:
   1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
   2. Base: [Plastic] [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:
   1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
   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 supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.6 PIPE POSITIONING SYSTEMS

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

2.7 EQUIPMENT SUPPORTS

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

2.8 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.
B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
   1. Properties: Nonstaining, noncorrosive, and nongaseous.
   2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
   1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.

2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Fiberglass Pipe-Hanger Installation: Comply with applicable portions of MSS SP-69 and MSS SP-89. Install hangers and attachments as required to properly support piping from building structure.

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

E. Fiberglass Strut System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled fiberglass struts.

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

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

H. Pipe Stand Installation:
1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 077200 "Roof Accessories" for curbs.

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

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

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

L. 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.

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

N. 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.

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

P. 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.

Q. 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 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

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

3.4 ADJUSTING

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

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
   1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils .
B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in [Section 099113 "Exterior Painting."] [Section 099123 "Interior Painting."] [Section 099600 "High-Performance Coatings."]
C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
E. Use carbon-steel pipe hangers and supports metal trapeze pipe hangers and metal framing systems and attachments for general service applications.
F. Use corrosion-resistant attachments for hostile environment applications.

G. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.
H. Use padded hangers for piping that is subject to scratching.
I. Use thermal-hanger shield inserts for insulated piping and tubing.
J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
   2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
   3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
   4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
   5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
   6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
   7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
   8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
   9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
   10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
   11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
   12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
   13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
   14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
   15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
   16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
   17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
   18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
   19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is 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.
K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
   2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

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

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

N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
   2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
   3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
   2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
   3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
   4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
   5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.

6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
   a. Horizontal (MSS Type 54): Mounted horizontally.
   b. Vertical (MSS Type 55): Mounted vertically.
   c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

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

Q. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

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

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

END OF SECTION 220529

SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Equipment labels.
   2. Warning signs and labels.
   3. Pipe labels.
   4. Stencils.
   5. Valve tags.
   6. Warning tags.

1.3 SUBMITTALS

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

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

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

D. Valve numbering scheme.

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

1.4 COORDINATION

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

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

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

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Plastic Labels for Equipment:
   1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1.8 thick, and having predrilled holes for attachment hardware.
   2. Letter Color: Black.
   3. Background Color: White.

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

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

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

D. Include Owner furnished Contractor installed devices.

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: Black Blue Red White Yellow.

C. Background Color: Black Blue Red White 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 partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.

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

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
   1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
   2. Lettering Size: At least 1-1/2 inches high.

2.4 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.

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.

2.5 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 Approximately 4 by 7 inches...
   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 encapsulates.

3.2 EQUIPMENT LABEL INSTALLATION

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

B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
   1. Near each valve and control device.
   2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
   3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
   4. At access doors, manholes, and similar access points that permit view of concealed piping.
   5. Near major equipment items and other points of origination and termination.
   6. Spaced at maximum intervals of 25 feet along each run. Reduce intervals to 15 feet in areas of congested piping and equipment.
   7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
   8. Labels to describe service:
      a. Domestic Hot Water Supply
      b. Domestic Hot Water Return, etc.

B. Pipe Label Color Schedule:
   1. Domestic Water Piping:
      a. Background Color: Yellow.
      b. Letter Color: Black.
   2. Sanitary Waste and Vent Piping:
      a. Background Color: White.
      b. Letter Color: Blue.

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.

3.5 WARNING-TAG INSTALLATION

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

END OF SECTION 220553

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. Cellular glass.
      b. Flexible elastomeric.
      c. Mineral fiber.
   2. Insulating cements.
   3. Adhesives.
   4. Mastics.
   5. Lagging adhesives.
   6. Sealants.
   7. Factory-applied jackets.
   8. Field-applied fabric-reinforcing mesh.
   9. Field-applied cloths.
   10. Field-applied jackets.
   11. Tapes.
   12. Securements.
   13. Corner angles.

B. Section 018113 "Sustainable Construction Requirements."

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. Qualification Data: For qualified Installer.

C. 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.

D. Field quality-control reports.

E. LEED Submittals:
   1. All submittals shall comply with LEED V4.
   2. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content.
   3. 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."

4. Submit MSDS sheets showing compliance with Section 018113 – Substantial Construction Requirements.

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.

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 Section 220529 "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.

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. All insulation and associated materials shall comply with LEED V4.

C. Products shall comply with VOC limitations as indicated in section 018113 – Sustainable Construction Requirements.

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

E. 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.

F. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

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

H. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   1. Products: Subject to compliance with requirements, provide the following provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Cell-U-Foam Corporation; Ultra-CUF.
      b. Pittsburgh Corning Corporation; Foamglas Super K.
   2. Block Insulation: ASTM C 552, Type I.
   3. Special-Shaped Insulation: ASTM C 552, Type III.
   4. Board Insulation: ASTM C 552, Type IV.
   5. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
   6. Preformed Pipe Insulation with Factory-Applied ASJ-SSL: Comply with ASTM C 552, Type II, Class 2.
   7. Factory fabricates shapes according to ASTM C 450 and ASTM C 585.

I. 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 the following provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Aero flex USA Inc.; Aerocel.
      b. Armacell LLC; AP Armaflex.
      c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.

J. 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 the following provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Certain Teed 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.

K. Mineral-Fiber, Preformed Pipe Insulation:
1. Products: Subject to compliance with requirements, provide the following provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
a. Fibrex Insulations Inc.; Coreplus 1200.
b. Johns Manville; Micro-Lok.
c. Knauf Insulation; 1000 Pipe Insulation.
d. Manson Insulation Inc.; Alley-K.
e. Owens Corning; Fiberglas Pipe Insulation.
2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

L. 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 available products that may be incorporated into the Work include, but are not limited to, the following:
a. Certain Teed Corp.; Crimp Wrap.
b. Johns Manville; Micro Flex.
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 it and to surfaces to be insulated, unless otherwise indicated.
1. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D EPA Method 24.

B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
a. Childers Products, Division of ITW; CP-82.
b. Foster Products Corporation, H. B. Fuller Company; 85-20.
c. ITW TACC, Division of Illinois Tool Works; S-90/80.
d. Marathon Industries, Inc.; 225.
e. Mon-Eco Industries, Inc.; 22-25.

C. 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 available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Childers Products, Division of ITW; CP-82.
   b. Foster Products Corporation, H. B. Fuller Company; 85-20.
   c. ITW TACC, Division of Illinois Tool Works; S-90/80.
   d. Marathon Industries, Inc.; 225.
   e. Mon-Eco Industries, Inc.; 22-25.
2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D EPA Method 24.

D. PVC Jacket Adhesive: Compatible with PVC jacket.
1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Dow Chemical Company the; 739, Dow Silicone.
   b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
   c. P.I.C. Plastics, Inc.; Welding Adhesive.
   d. Speedline Corporation; Speedline Vinyl Adhesive.
   2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D EPA Method 24.

2.3 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 available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Childers Products, Division of ITW; CP-35.
   b. Foster Products Corporation, H. B. Fuller Company; 30-90.
   c. ITW TACC, Division of Illinois Tool Works; CB-50.
   d. Marathon Industries, Inc.; 590.
   e. Mon-Eco Industries, Inc.; 55-40.
   f. Vimasco Corporation; 749.
2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
5. Color: White.

C. 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 available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Childers Products, Division of ITW; CP-30.
   b. Foster Products Corporation, H. B. Fuller Company; 30-35.
   c. ITW TACC, Division of Illinois Tool Works; CB-25.
   d. Marathon Industries, Inc.; 501.

e. 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 available products that may be incorporated into the Work include, but are not limited to, 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 SEALANTS

A. Joint Sealants:
1. Joint Sealants for Cellular-Glass, Phenolic, and Polyisocyanurate Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
a. Childers Products, Division of ITW; CP-76.
b. Foster Products Corporation, H. B. Fuller Company; 30-45.
c. Marathon Industries, Inc.; 405.
d. Mon-Eco Industries, Inc.; 44-05.
e. Pittsburgh Corning Corporation; Pittseal 444.
f. Vimasco Corporation; 750.
2. Joint Sealants for Polystyrene Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
a. Childers Products, Division of ITW; CP-70.
b. Foster Products Corporation, H. B. Fuller Company; 30-45/30-46.
c. Marathon Industries, Inc.; 405.
d. Mon-Eco Industries, Inc.; 44-05.
e. Vimasco Corporation; 750.
3. Materials shall be compatible with insulation materials, jackets, and substrates.
4. Permanently flexible, elastomeric sealant.
5. Service Temperature Range: Minus 100 to plus 300 deg F.
6. Color: White or gray.
7. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D EPA Method 24

B. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
a. Childers Products, Division of ITW; CP-76.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F...
5. Color: White.
6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D EPA Method 24.

2.5 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
   1. ASJ: White, Kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I (Cellular Glass).
   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 (Cellular Glass).
   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 one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
         1) Dow Chemical Company; 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 one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
         1) Dow Chemical Company; 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 one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
         1) Dow Chemical Company; Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.

B. Metal Jacket:
   1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Childers Products, Division of ITW; Metal Jacketing Systems.
      b. PABCO Metals Corporation; Sure fit.
      c. RPR Products, Inc.; Insul-Mate.

2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105 or 5005, and 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-mil- thick, heat-bonded polyethylene and Kraft paper 3-mil- thick, heat-bonded polyethylene and Kraft paper.
   d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and Kraft paper.
   e. Factory-Fabricated Fitting Covers:
      1) Same material, finish, and thickness as jacket.
      2) Preformed 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 fabricates fitting covers only if factory-fabricated fitting covers are not available.

2.6 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 available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.
      b. Compac Corp.; 104 and 105.
      c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
      d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
   2. Width: 3 inches.
   3. Thickness: 11.5 mils.
   4. Adhesion: 90 ounces force/inch. In width.
   5. Elongation: 2 percent.
   6. Tensile Strength: 40 lbf / inch. In width.
   7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
   1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
      b. Compac Corp.; 110 and 111.
      c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.
      d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.
   2. Width: 3 inches.
   3. Thickness: 6.5 mils.
   4. Adhesion: 90 ounces force/inch in width.
   5. Elongation: 2 percent.

6. Tensile Strength: 40 lb 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 available products that may be incorporated into the Work include, but are not limited to, the following:
a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0555.
b. Compac Corp.; 130.
c. Ideal Tape Co., Inc., an American Biltrite Company; 370 White PVC tape.
d. Venture Tape; 1506 CW NS.
2. Width: 2 inches.
3. Thickness: 6 mils.
4. Adhesion: 64 ounces force/inch in width.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
b. Compac Corp.; 120.
c. Ideal Tape Co., Inc., an American Biltrite Company; 488 AWF.
d. Venture Tape; 3520 CW.
2. Width: 2 inches.
3. Thickness: 3.7 mils.
4. Adhesion: 100 ounces force/inch in width.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch in width.

E. PVDC Tape: White vapor-retarder PVDC tape with acrylic adhesive.
1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
a. Dow Chemical Company the; Saran 540 Vapor Retarder Tape.
2. Width: 3 inches.
3. Film Thickness: 4 mils, 6 mils.
4. Adhesive Thickness: 1.5 mils.
5. Elongation at Break: 145 percent.
6. Tensile Strength: 55 lbf/inch in width.

2.7 CORNER ANGLES

A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch , aluminum according to ASTM B 209 , Alloy 3003, 3005, 3105 or 5005; Temper H-14.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
   1. Verify that systems and equipment to be insulated have been tested and are free of defects.
   2. Verify that surfaces to be insulated are clean and dry.
   3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

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

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

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment 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. Applies to existing where damaged within work areas as a result of this project.

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 Rate`d: 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 "Firestopping" and Division 07 Section "Joint Sealers".
   2. Refer to Section 220500 "Common Work Results for Plumbing".

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 "Firestopping."
   3. Refer to Section 220500 "Common Work Results for Plumbing."

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, 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.

E. 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 cut sections of block insulation of same material and thickness as pipe insulation.
4. Finish flange insulation same as pipe insulation.

F. Insulation Installation on Pipe Fittings and Elbows:
1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed insulation sections of insulation are not available, install mitered sections of calcium silicate insulation. Secure insulation materials with wire or bands.
3. Finish fittings insulation same as pipe insulation.

G. Insulation Installation on Valves and Pipe Specialties:
1. Install mitered segments of calcium silicate insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
2. Install insulation to flanges as specified for flange insulation application.
3. Finish valve and specialty insulation same as pipe insulation.

3.6 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

A. Seal longitudinal seams and end joints with manufacturers 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 manufacturers 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 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.
   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.

3.8 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
   1. Draw jacket smooth ‘and tight to surface with 2-inch overlap at seams and joints.
   2. Embed glass cloth between two 0.062-inch- thick coats of lagging adhesive.
   3. Completely encapsulate insulation with coating, leaving no exposed insulation.

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

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

3.9 PIPING INSULATION SCHEDULE, GENERAL

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

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
   1. Drainage piping located in crawl spaces.
   2. Underground piping.
   3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.10 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Cold Water - ALL:
   1. Insulation shall be the following:
      a. Cellular Glass: 1" thick. ASJ-SSL jacket.

B. Domestic Hot and Recirculated Hot Water - ALL:
   1. Insulation shall be the following:
      a. Cellular Glass: 1-1/2" thick. ASJ-SSL jacket.

C. Condensate and Equipment Drain Water below 60 Deg F:
   1. All Pipe Sizes: Insulation shall be one of the following:
      a. Flexible Elastomeric: 3/4:" thick.
      b. Cellular glass 1" thick.

D. For outdoor applications include metal jacket as specified hereinbefore.

E. Horizontal Storm Drain Piping:
   1. All Pipe Sizes: Insulation shall be one of the following:
      a. Mineral-Fiber Pipe Insulation, Type I: 1" thick.

F. Roof Drain Body:
   1. Roof Drain Body: Insulation shall be one of the following:
      a. Mineral-Fiber Pipe Insulation, Type I: 1" thick.

END OF SECTION 220700

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. Cellular glass.
      b. Flexible elastomeric.
      c. Mineral fiber.
   2. Insulating cements.
   3. Adhesives.
   4. Mastics.
   5. Lagging adhesives.
   6. Sealants.
   7. Factory-applied jackets.
   8. Field-applied fabric-reinforcing mesh.
   9. Field-applied cloths.
   10. Field-applied jackets.
   11. Tapes.
   12. Securements.
   13. Corner angles.

B. Section 018113 "Sustainable Construction Requirements."

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. Qualification Data: For qualified Installer.

C. 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.

D. Field quality-control reports.

1.4 QUALITY ASSURANCE

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

B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
   1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

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 Section 220529 "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.

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. All insulation and associated materials shall comply with local AHJ requirements.

C. Products shall comply with VOC limitations as indicated in section 018113 – Sustainable Construction Requirements.

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

E. 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.

F. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

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

H. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   1. Products: Subject to compliance with requirements, provide the following provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Cell-U-Foam Corporation; Ultra-CUF.
      b. Pittsburgh Corning Corporation; Foamglas Super K.
   2. Block Insulation: ASTM C 552, Type I.
   3. Special-Shaped Insulation: ASTM C 552, Type III.
   4. Board Insulation: ASTM C 552, Type IV.
   5. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
   6. Preformed Pipe Insulation with Factory-Applied ASJ-SSL: Comply with ASTM C 552, Type II, Class 2.
   7. Factory fabricates shapes according to ASTM C 450 and ASTM C 585.

I. 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 the following provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Aero flex USA Inc.; Aerocel.
      b. Armacell LLC; AP Armaflex.
      c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.

J. 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 the following provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Certain Teed 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.

K. Mineral-Fiber, Preformed Pipe Insulation:
1. Products: Subject to compliance with requirements, provide the following provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
a. Fibrex Insulations Inc.; Coreplus 1200.
b. Johns Manville; Micro-Lok.
c. Knauf Insulation; 1000 Pipe Insulation.
d. Manson Insulation Inc.; Alley-K.
e. Owens Corning; Fiberglas Pipe Insulation.
2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

L. 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 available products that may be incorporated into the Work include, but are not limited to, the following:
a. Certain Teed Corp.; Crimp Wrap.
b. Johns Manville; Micro Flex.
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 it and to surfaces to be insulated, unless otherwise indicated.
1. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D EPA Method 24.

B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
a. Childers Products, Division of ITW; CP-82.
b. Foster Products Corporation, H. B. Fuller Company; 85-20.
c. ITW TACC, Division of Illinois Tool Works; S-90/80.
d. Marathon Industries, Inc.; 225.
e. Mon-Eco Industries, Inc.; 22-25.

C. 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 available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Childers Products, Division of ITW; CP-82.
   b. Foster Products Corporation, H. B. Fuller Company; 85-20.
   c. ITW TACC, Division of Illinois Tool Works; S-90/80.
   d. Marathon Industries, Inc.; 225.
   e. Mon-Eco Industries, Inc.; 22-25.
2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D EPA Method 24.

D. PVC Jacket Adhesive: Compatible with PVC jacket.
1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Dow Chemical Company the; 739, Dow Silicone.
   b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
   c. P.I.C. Plastics, Inc.; Welding Adhesive.
   d. Speedline Corporation; Speedline Vinyl Adhesive.
   2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D EPA Method 24.

2.3 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 available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Childers Products, Division of ITW; CP-35.
   b. Foster Products Corporation, H. B. Fuller Company; 30-90.
   c. ITW TACC, Division of Illinois Tool Works; CB-50.
   d. Marathon Industries, Inc.; 590.
   e. Mon-Eco Industries, Inc.; 55-40.
   f. Vimasco Corporation; 749.
2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
5. Color: White.

C. 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 available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Childers Products, Division of ITW; CP-30.
   b. Foster Products Corporation, H. B. Fuller Company; 30-35.
   c. ITW TACC, Division of Illinois Tool Works; CB-25.
   d. Marathon Industries, Inc.; 501.

e. 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 available products that may be incorporated into the Work include, but are not limited to, 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 SEALANTS

A. Joint Sealants:
1. Joint Sealants for Cellular-Glass, Phenolic, and Polyisocyanurate Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
a. Childers Products, Division of ITW; CP-76.
b. Foster Products Corporation, H. B. Fuller Company; 30-45.
c. Marathon Industries, Inc.; 405.
d. Mon-Eco Industries, Inc.; 44-05.
e. Pittsburgh Corning Corporation; Pittseal 444.
f. Vimasco Corporation; 750.
2. Joint Sealants for Polystyrene Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
a. Childers Products, Division of ITW; CP-70.
b. Foster Products Corporation, H. B. Fuller Company; 30-45/30-46.
c. Marathon Industries, Inc.; 405.
d. Mon-Eco Industries, Inc.; 44-05.
e. Vimasco Corporation; 750.
3. Materials shall be compatible with insulation materials, jackets, and substrates.
4. Permanently flexible, elastomeric sealant.
5. Service Temperature Range: Minus 100 to plus 300 deg F.
6. Color: White or gray.
7. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D EPA Method 24

B. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
a. Childers Products, Division of ITW; CP-76.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F...
5. Color: White.
6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D EPA Method 24.

2.5 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
   1. ASJ: White, Kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I (Cellular Glass).
   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 (Cellular Glass).
   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 one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
         1) Dow Chemical Company; 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 one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
         1) Dow Chemical Company; 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 one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
         1) Dow Chemical Company; Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.

B. Metal Jacket:
   1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Childers Products, Division of ITW; Metal Jacketing Systems.
      b. PABCO Metals Corporation; Sure fit.
      c. RPR Products, Inc.; Insul-Mate.

2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105 or 5005, and 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-mil- thick, heat-bonded polyethylene and Kraft paper 3-mil- thick, heat-bonded polyethylene and Kraft paper.
   d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and Kraft paper.
   e. Factory-Fabricated Fitting Covers:
      1) Same material, finish, and thickness as jacket.
      2) Preformed 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 fabricates fitting covers only if factory-fabricated fitting covers are not available.

2.6 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 available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.
      b. Compac Corp.; 104 and 105.
      c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
      d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
   2. Width: 3 inches.
   3. Thickness: 11.5 mils.
   4. Adhesion: 90 ounces force/inch. In width.
   5. Elongation: 2 percent.
   6. Tensile Strength: 40 lbf / inch. In width.
   7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
   1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
      b. Compac Corp.; 110 and 111.
      c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.
      d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.
   2. Width: 3 inches.
   3. Thickness: 6.5 mils.
   4. Adhesion: 90 ounces force/inch in width.
   5. Elongation: 2 percent.

6. Tensile Strength: 40 lb 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 available products that may be incorporated into the Work include, but are not limited to, the following:
a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0555.
b. Compac Corp.; 130.
c. Ideal Tape Co., Inc., an American Biltrite Company; 370 White PVC tape.
d. Venture Tape; 1506 CW NS.
2. Width: 2 inches.
3. Thickness: 6 mils.
4. Adhesion: 64 ounces force/inch in width.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
b. Compac Corp.; 120.
c. Ideal Tape Co., Inc., an American Biltrite Company; 488 AWF.
d. Venture Tape; 3520 CW.
2. Width: 2 inches.
3. Thickness: 3.7 mils.
4. Adhesion: 100 ounces force/inch in width.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch in width.

E. PVDC Tape: White vapor-retarder PVDC tape with acrylic adhesive.
1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
a. Dow Chemical Company the; Saran 540 Vapor Retarder Tape.
2. Width: 3 inches.
3. Film Thickness: 4 mils, 6 mils.
4. Adhesive Thickness: 1.5 mils.
5. Elongation at Break: 145 percent.
6. Tensile Strength: 55 lbf/inch in width.

2.7 CORNER ANGLES

A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch , aluminum according to ASTM B 209 , Alloy 3003, 3005, 3105 or 5005; Temper H-14.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
   1. Verify that systems and equipment to be insulated have been tested and are free of defects.
   2. Verify that surfaces to be insulated are clean and dry.
   3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

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

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

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment 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. Applies to existing where damaged within work areas as a result of this project.

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 Rate`d: 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 "Firestopping" and Division 07 Section "Joint Sealers".
   2. Refer to Section 220500 "Common Work Results for Plumbing".

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 "Firestopping."
   3. Refer to Section 220500 "Common Work Results for Plumbing."

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, 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.

E. 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 cut sections of block insulation of same material and thickness as pipe insulation.
4. Finish flange insulation same as pipe insulation.

F. Insulation Installation on Pipe Fittings and Elbows:
1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed insulation sections of insulation are not available, install mitered sections of calcium silicate insulation. Secure insulation materials with wire or bands.
3. Finish fittings insulation same as pipe insulation.

G. Insulation Installation on Valves and Pipe Specialties:
1. Install mitered segments of calcium silicate insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
2. Install insulation to flanges as specified for flange insulation application.
3. Finish valve and specialty insulation same as pipe insulation.

3.6 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

A. Seal longitudinal seams and end joints with manufacturers 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 manufacturers 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 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.
   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.

3.8 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
   1. Draw jacket smooth ‘and tight to surface with 2-inch overlap at seams and joints.
   2. Embed glass cloth between two 0.062-inch- thick coats of lagging adhesive.
   3. Completely encapsulate insulation with coating, leaving no exposed insulation.

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

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

3.9 PIPING INSULATION SCHEDULE, GENERAL

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

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
   1. Drainage piping located in crawl spaces.
   2. Underground piping.
   3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.10 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Cold Water - ALL:
   1. Insulation shall be the following:
      a. Cellular Glass: 1" thick. ASJ-SSL jacket.

B. Domestic Hot and Recirculated Hot Water - ALL:
   1. Insulation shall be the following:
      a. Cellular Glass: 1-1/2" thick. ASJ-SSL jacket.

C. Condensate and Equipment Drain Water below 60 Deg F:
   1. All Pipe Sizes: Insulation shall be one of the following:
      a. Flexible Elastomeric: 3/4:" thick.
      b. Cellular glass 1" thick.

D. For outdoor applications include metal jacket as specified hereinbefore.

E. Horizontal Storm Drain Piping:
   1. All Pipe Sizes: Insulation shall be one of the following:
      a. Mineral-Fiber Pipe Insulation, Type I: 1" thick.

F. Roof Drain Body:
   1. Roof Drain Body: Insulation shall be one of the following:
      a. Mineral-Fiber Pipe Insulation, Type I: 1" thick.

END OF SECTION 220700

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.
   2. Encasement for piping.

B. Related Requirements:
   1. Section 221113 "Facility Water Distribution Piping" for water-service piping [and water meters] 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."

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 [Architect] [Construction Manager] [Owner] no fewer than [two] <Insert number> days in advance of proposed interruption of water service.
   2. Do not interrupt water service without Owner's written permission.

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."

2.2 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B) water tube, drawn temper.

B. Soft Copper Tube: ASTM B 88, Type K (ASTM B 88M, Type A) 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.

G. Copper Pressure-Seal-Joint Fittings:
1. Manufacturers:
2. Basis-of-Design Product:
   a. Elkhart Products Corporation.
   b. NIBCO Inc.
   c. Viega.
3. Fittings for NPS 2 (DN 50) and Smaller: Wrought-copper fitting with EPDM-rubber, O-ring seal in each end.
4. Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Cast-bronze or wrought-copper fitting with EPDM-rubber, O-ring seal in each end.

H. Copper Push-on-Joint Fittings:
1. Manufacturers:
   a. Victaulic Company.
2. Description:
   a. Cast-copper fitting complying with ASME B16.18 or wrought-copper fitting complying with ASME B 16.22.
   b. Stainless-steel teeth and EPDM-rubber, O-ring seal in each end instead of solder-joint ends.

I. Copper-Tube, Extruded-Tee Connections:
1. Manufacturers
   a. T-Drill Industries Inc.
2. Description: Tee formed in copper tube according to ASTM F 2014.

J. Appurtenances for Grooved-End Copper Tubing:
1. Manufacturers:
   a. Anvil International.
   b. Shurjoint Piping Products.
   c. Victaulic Company.
2. Bronze Fittings for Grooved-End, Copper Tubing: ASTM B 75 (ASTM B 75M) copper tube or ASTM B 584 bronze castings.
3. Mechanical Couplings for Grooved-End Copper Tubing:
   a. Copper-tube dimensions and design similar to AWWA C606.
   b. Ferrous housing sections.
   c. EPDM-rubber gaskets suitable for hot and cold water.
   d. Bolts and nuts.
   e. Minimum Pressure Rating: 300 psig (2070 kPa).

2.3 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials:
1. AWWA C110/A21.10, rubber, flat face, 1/8 inch (3.2 mm) 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.

F. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F 493.
1. CPVC solvent cement shall have a VOC content of 490 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. 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).
3. Solvent cement and 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."

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 the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
   2. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer's name; product name or designation> or comparable product 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
   2. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
      a. Charlotte Pipe and Foundry Company.
      b. Harvel Plastics, Inc.
      c. Spears Manufacturing Company.
      d. <Insert manufacturer's name>.
   3. 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 the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
   2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawingsor comparable product by one of the following:
      a. Colonial Engineering, Inc.
      b. NIBCO Inc.
      c. Spears Manufacturing Company.
   3. Description:
      a. CPVC or PVC four-part union.
      b. Brass[or stainless-steel] threaded end.
      c. Solvent-cement-joint[or threaded] 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 Unions:
   1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
   2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawingsor comparable product by one of the following:
      a. Capitol Manufacturing Company; member of the Phoenix Forge Group.
      b. Central Plastics Company.
      c. Hart Industries International, Inc.
      d. Jomar International.
      e. Matco-Norca.
      f. McDonald, A. Y. Mfg. Co.
      g. Watts; a division of Watts Water Technologies, Inc.
      h. Wilkins; a Zurn company.
   3. Standard: ASSE 1079.
   4. Pressure Rating: psig (1035 kPa)] [250 psig (1725 kPa)
   5. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:
   1. Manufacturers:
      a. Capitol Manufacturing Company; member of the Phoenix Forge Group.
      b. Central Plastics Company.
      c. Matco-Norca.
      d. Watts; a division of Watts Water Technologies, Inc.
      e. Wilkins; a Zurn company.
   2. Standard: ASSE 1079.
   3. Factory-fabricated, bolted, companion-flange assembly.
   4. Pressure Rating: 150 psig (1035 kPa)
   5. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:
   1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
   2. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
      a. Advance Products & Systems, Inc.
      b. Calpico, Inc.
      c. Central Plastics Company.
      d. Pipeline Seal and Insulator, Inc.
   3. Nonconducting materials for field assembly of companion flanges.
   4. Pressure Rating: [150 psig (1035 kPa)] <Insert value>.
   5. Gasket: Neoprene or phenolic.
   6. Bolt Sleeves: Phenolic or polyethylene.
   7. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples:
   1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
   2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

a. Elster Perfection Corporation.
b. Grinnell Mechanical Products; Tyco Fire Products LP.
c. Matco-Norca.
d. Precision Plumbing Products, Inc.
e. Victaulic Company.

3. Standard: IAPMO PS 66.
4. Electroplated steel nipple complying with ASTM F 1545.
5. Pressure Rating and Temperature: 300 psig (2070 kPa) at 225 deg F (107 deg C)
6. End Connections: Male threaded or grooved.
7. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Comply with requirements in Section 312000 "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 ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.
D. Install underground [copper tube] [and] [ductile-iron pipe] in PE encasement according to ASTM A 674 or AWWA C105/A21.5.
E. 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 Section 220519 "Meters and Gages for Plumbing Piping" and with requirements for drain valves and strainers in Section 221119 "Domestic Water Piping Specialties."
F. Install shutoff valve immediately upstream of each dielectric fitting.
G. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in Section 221119 "Domestic Water Piping Specialties."
H. Install domestic water piping level [with 0.25 percent slope downward toward drain] [without pitch] and plumb.
I. Rough-in domestic water piping for water-meter installation according to utility company's requirements.
J. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
K. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
L. 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.
M. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
N. Install piping to permit valve servicing.
O. 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.
P. Install piping free of sags and bends.
Q. Install fittings for changes in direction and branch connections.
R. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
S. Install pressure gages on suction and discharge piping for each plumbing pump and packaged booster pump. Comply with requirements for pressure gages in Section 220519 "Meters and Gages for Plumbing Piping."

T. Install thermostats in hot-water circulation piping. Comply with requirements for thermostats in Section 221123 "Domestic Water Pumps."
U. Install thermometers on[inlet and] outlet piping from each water heater. Comply with requirements for thermometers in Section 220519 "Meters and Gages for Plumbing Piping."
V. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
W. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
X. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "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. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.
G. Push-on Joints for Copper Tubing: Clean end of tube. Measure insertion depth with manufacturer's depth gage. Join copper tube and push-on-joint fittings by inserting tube to measured depth.
H. Extruded-Tee Connections: Form tee in copper tube according to ASTM F 2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.
I. Joint Construction for Grooved-End Copper Tubing: Make joints according to AWWA C606. Roll groove ends of tubes. Lubricate and install gasket over ends of tubes or tube and fitting. Install coupling housing sections over gasket with keys seated in tubing grooves. Install and tighten housing bolts.
J. Joint Construction for Grooved-End, Ductile-Iron Piping: Make joints according to AWWA C606. Cut round-bottom grooves in ends of pipe at gasket-seat dimension required for specified (flexible or rigid) joint. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.
K. Joint Construction for Grooved-End Steel Piping: Make joints according to AWWA C606. [Square cut] [Roll] groove ends of pipe as specified. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.
L. 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.
M. Joint Construction for Solvent-Cemented Plastic Piping: 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. Apply primer.
2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
3. PVC Piping: Join according to ASTM D 2855.
N. Joints for PEX Piping: Join according to ASTM F 1807.

O. 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 (DN 40) and Smaller: Fitting-type coupling.
   2. Fittings for NPS 2 (DN 50) and Larger: Sleeve-type coupling.
C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 (DN 50) and Smaller: Plastic-to-metal transition [fittings] [or] [unions].

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 (DN 50) and Smaller: Use dielectric [couplings] [couplings or nipples] [nipples] [unions].
C. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric flanges
D. Dielectric Fittings for NPS 5 (DN 125) and Larger: Use dielectric flange kits.

3.6 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for seismic-restraint devices in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
B. Comply with requirements for pipe hanger, support products, and installation in Section 220529 "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 (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
      b. Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
      c. Longer Than 100 Feet (30 m) if Indicated: MSS Type 49, spring cushion rolls.
   3. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
   4. Base of Vertical Piping: MSS Type 52, spring hangers.
C. 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 (10 mm).
E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 3/4 (DN 20) and Smaller: 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
   2. NPS 1 and NPS 1-1/4 (DN 25 and DN 32): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
   3. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
   4. NPS 2-1/2 (DN 65): 108 inches (2700 mm) with 1/2-inch (13-mm) rod.
   5. NPS 3 to NPS 5 (DN 80 to DN 125): 10 feet (3 m) with 1/2-inch (13-mm) rod.
   6. NPS 6 (DN 150): 10 feet (3 m) with 5/8-inch (16-mm) rod.
   7. NPS 8 (DN 200): 10 feet (3 m) with 3/4-inch (19-mm) rod.
F. Install supports for vertical copper tubing every 10 feet (3 m).
G. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/4 (DN 32) and Smaller: 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
   2. NPS 1-1/2 (DN 40): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.
   3. NPS 2 (DN 50): 10 feet (3 m) with 3/8-inch (10-mm) rod.
   4. NPS 2-1/2 (DN 65): 11 feet (3.4 m) with 1/2-inch (13-mm) rod.
   5. NPS 3 and NPS 3-1/2 (DN 80 and DN 90): 12 feet (3.7 m) with 1/2-inch (13-mm) rod.
   6. NPS 4 and NPS 5 (DN 100 and DN 125): 12 feet (3.7 m) with 5/8-inch (16-mm) rod.
   7. NPS 6 (DN 150): 12 feet (3.7 m) with 3/4-inch (19-mm) rod.
   8. NPS 8 to NPS 12 (DN 200 to DN 300): 12 feet (3.7 m) with 7/8-inch (22-mm) rod.
H. Install supports for vertical steel piping every 15 feet (4.5 m).
I. Install hangers for stainless-steel piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/4 (DN 32) and Smaller: 84 inches (2100 mm) with 3/8-inch (10-mm) rod.

2. NPS 1-1/2 (DN 40): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.
3. NPS 2 (DN 50): 10 feet (3 m) with 3/8-inch (10-mm) rod.
4. NPS 2-1/2 (DN 65): 11 feet (3.4 m) with 1/2-inch (13-mm) rod.
5. NPS 3 and NPS 3-1/2 (DN 80 and DN 90): 12 feet (3.7 m) with 1/2-inch (13-mm) rod.
6. NPS 4 and NPS 5 (DN 100 and DN 125): 12 feet (3.7 m) with 5/8-inch (16-mm) rod.
7. NPS 6 (DN 150): 12 feet (3.7 m) with 3/4-inch (19-mm) rod.
8. NPS 8 to NPS 12 (DN 200 to DN 300): 12 feet (3.7 m) with 7/8-inch (22-mm) rod.

J. Install supports for vertical stainless-steel piping every 15 feet (4.5 m).

K. Install vinyl-coated hangers for CPVC piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1 (DN 25) and Smaller: 36 inches (900 mm) with 3/8-inch (10-mm) rod.
2. NPS 1-1/4 to NPS 2 (DN 32 to DN 50): 48 inches (1200 mm) with 3/8-inch (10-mm) rod.
3. NPS 2-1/2 to NPS 3-1/2 (DN 65 to DN 90): 48 inches (1200 mm) with 1/2-inch (13-mm) rod.
4. NPS 4 and NPS 5 (DN 100 and DN 125): 48 inches (1200 mm) with 5/8-inch (16-mm) rod.
5. NPS 6 (DN 150): 48 inches (1200 mm) with 3/4-inch (19-mm) rod.
6. NPS 8 (DN 200): 48 inches (1200 mm) with 7/8-inch (22-mm) rod.

L. Install supports for vertical CPVC piping every 60 inches (1500 mm) for NPS 1 (DN 25) and smaller, and every 72 inches (1800 mm) for NPS 1-1/4 (DN 32) and larger.

M. Install vinyl-coated hangers for PEX piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1 (DN 25) and Smaller: 32 inches (815 mm) with 3/8-inch (10-mm) rod.

N. Install hangers for vertical PEX piping every 48 inches (1200 mm).

O. Install vinyl-coated hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 2 (DN 50) and Smaller: 48 inches (1200 mm) with 3/8-inch (10-mm) rod.
2. NPS 2-1/2 to NPS 3-1/2 (DN 65 to DN 90): 48 inches (1200 mm) with 1/2-inch (13-mm) rod.
3. NPS 4 and NPS 5 (DN 100 and DN 125): 48 inches (1200 mm) with 5/8-inch (16-mm) rod.
4. NPS 6 (DN 150): 48 inches (1200 mm) with 3/4-inch (19-mm) rod.
5. NPS 8 (DN 200): 48 inches (1200 mm) with 7/8-inch (22-mm) rod.

P. Install supports for vertical PVC piping every 48 inches (1200 mm).

Q. Install vinyl-coated hangers for PP piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1 (DN 25) and Smaller: 36 inches (900 mm) with 3/8-inch (10-mm) rod.
2. NPS 1-1/4 to NPS 2 (DN 32 to DN 50): 48 inches (1200 mm) with 3/8-inch (10-mm) rod.
3. NPS 2-1/2 to NPS 3-1/2 (DN 65 to DN 90): 48 inches (1200 mm) with 1/2-inch (13-mm) rod.
4. NPS 4 and NPS 5 (DN 100 and DN 125): 48 inches (1200 mm) with 5/8-inch (16-mm) rod.
5. NPS 6 (DN 150): 48 inches (1200 mm) with 3/4-inch (19-mm) rod.
6. NPS 8 (DN 200): 48 inches (1200 mm) with 7/8-inch (22-mm) rod.

R. Install supports for vertical PP piping every 60 inches (1500 mm) for NPS 1 (DN 25) and smaller, and every 72 inches (1800 mm) for NPS 1-1/4 (DN 32) and larger.

S. 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. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
3. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.

4. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 (DN 65) and larger.

3.8 IDENTIFICATION

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

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 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
   e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
   f. Prepare reports for tests and for corrective action required.

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

C. Prepare test and inspection reports.

3.10 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 (50 mg/L) 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 (200 mg/L) 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. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

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

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

D. Under-building-slab, domestic water, building-service piping, shall be one of the following:
   1. Soft copper tube, ASTM B 88, Type K (ASTM B 88M, Type A) joints.
   2. PVC, Schedule 80; socket fittings; and solvent-cemented joints.

E. Under-building-slab, domestic water, building-service piping, shall be one of the following:
   1. Soft copper tube, [STM B 88, Type K (ASTM B 88M, Type A); wrought-copper, solder-joint fittings; and brazed joints.
   2. PVC, Schedule 80; socket fittings; and solvent-cemented joints.

F. Under-building-slab, combined domestic water, building-service, and fire-service-main piping, NPS 6 to NPS 12 (DN 150 to DN 300), shall be[one of] the following:
   1. Mechanical-joint, ductile-iron pipe; standard- or compact-pattern, mechanical-joint fittings; and mechanical joints.
   2. Push-on-joint, ductile-iron pipe; standard- or compact-]pattern, push-on-joint fittings; and gasketed joints.
   3. Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.

G. Aboveground domestic water piping, shall be one of the following:

1. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B), solder-joint fittings; and [brazed] [soldered] joints.
2. CPVC, [Schedule 40] [Schedule 80]; socket fittings; and solvent-cemented 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 or gate valves for piping NPS 2 and smaller. Use butterfly, ball, or gate valves with flanged ends for piping NPS 2-1/2 and larger.
   2. Throttling Duty: Use ball or globe valves for piping NPS 2 and smaller. Use butterfly or ball 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.

C. Iron grooved-end valves may be used with grooved-end piping.

END OF SECTION 221116

SECTION 221119 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Vacuum breakers.
2. Backflow preventers.
3. Water pressure-reducing valves.
4. Balancing valves.
5. Temperature-actuated, water mixing valves.
6. Strainers.
7. Outlet boxes.
8. Hose stations.
9. Hose bibbs.
10. Wall hydrants.
11. Ground hydrants.
12. Post hydrants.
13. Drain valves.
14. Water-hammer arresters.
15. Air vents.
16. Trap-seal primer valves.
17. Trap-seal primer systems.
18. Specialty valves.
19. Flexible connectors.
20. Water meters.

B. Related Requirements:

1. Section 220519 "Meters and Gages for Plumbing Piping" for thermometers, pressure gages, and flow meters in domestic water piping.
2. Section 221116 "Domestic Water Piping" for water meters.
3. Section 223200 "Domestic Water Filtration Equipment" for water filters in domestic water piping.
4. Section 224300 "Medical Plumbing Fixtures" for thermostatic mixing valves for sitz baths, thermostatic mixing-valve assemblies for hydrotherapy equipment, and outlet boxes for dialysis equipment.
5. Section 224500 "Emergency Plumbing Fixtures" for water tempering equipment.
6. Section 224713 "Drinking Fountains" for water filters for water coolers.
7. Section 224716 "Pressure Water Coolers" for water filters for water coolers.
8. Section 224723 "Remote Water Coolers" for water filters for water coolers.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For domestic water piping specialties.

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

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

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

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

A. Potable-water piping and components shall comply with NSF 61[and NSF 14].[Mark "NSF-pw" on plastic piping components.]

2.2 PERFORMANCE REQUIREMENTS

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

2.3 VACUUM BREAKERS

A. Pipe-Applied, Atmospheric-Type Vacuum Breakers <Insert drawing designation if any>:
   1. Manufacturers:
      a. Conbraco Industries, Inc.
      b. FEBCO; a division of Watts Water Technologies, Inc.
      c. Rain Bird Corporation.
      d. Toro Company (The); Irrigation Div.
      e. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
      f. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
   2. Standard: ASSE 1001.
   3. Size: NPS 1/4 to NPS 3, as required to match connected piping.
   4. Body: Bronze.
   5. Inlet and Outlet Connections: Threaded.
   6. Finish: [Rough bronze] [Chrome plated].

B. Hose-Connection Vacuum Breakers:
   1. Manufacturers:
      a. Conbraco Industries, Inc.
      b. Legend Valve.
      c. MIFAB, Inc.
      d. Prier Products, Inc.
      e. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
      f. Woodford Manufacturing Company; a division of WCM Industries, Inc.
      g. Zurn Industries, LLC; Plumbing Products Group; Light Commercial Products.

h. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.

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] [Rough bronze].

C. Pressure Vacuum Breakers <Insert drawing designation if any>:
1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
2. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
a. Ames Fire & Waterworks; a division of Watts Water Technologies, Inc.
b. Conbraco Industries, Inc.
c. FEBCO; a division of Watts Water Technologies, Inc.
d. Flomatic Corporation.
e. Toro Company (The); Irrigation Div.
f. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
g. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
h. <Insert manufacturer's name>.
3. Standard: ASSE 1020.
4. Operation: Continuous-pressure applications.
5. Pressure Loss: [5 psig] <Insert value> maximum, through middle third of flow range.
6. Size: <Insert NPS>.
7. Design Flow Rate: <Insert gpm>.
8. Selected Unit Flow Range Limits: <Insert gpm>.
9. Pressure Loss at Design Flow Rate: <Insert psig>.
10. Accessories:
a. Valves: Ball type, on inlet and outlet.

D. Laboratory-Faucet Vacuum Breakers <Insert drawing designation if any>:
1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
2. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
a. Conbraco Industries, Inc.
b. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
c. Woodford Manufacturing Company; a division of WCM Industries, Inc.
d. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
e. <Insert manufacturer's name>.
3. Standard: ASSE 1035.

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

E. Spill-Resistant Vacuum Breakers <Insert drawing designation if any>:
1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
2. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
   a. Conbraco Industries, Inc.
   b. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
3. Standard: ASSE 1056.
4. Operation: Continuous-pressure applications.
5. Size: [NPS 1/4] [NPS 3/8] [NPS 1/2] [NPS 3/4] [NPS 1].
6. Accessories:
   a. Valves: Ball type, on inlet and outlet.

2.4 BACKFLOW PREVENTERS

A. Intermediate Atmospheric-Vent Backflow Preventers:
1. Manufacturers:
   a. Cash Acme; a division of Reliance Worldwide Corporation.
   b. Conbraco Industries, Inc.
   c. FEBCO; a division of Watts Water Technologies, Inc.
   d. Honeywell International Inc.
   e. Legend Valve.
   f. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
   g. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
2. Standard: ASSE 1012.
3. Operation: Continuous-pressure applications.
4. Size: [NPS 1/2] [NPS 3/4].
5. Body: Bronze.
6. End Connections: [Union, solder] [Solder] joint.
7. Finish: [Chrome plated] [Rough bronze].

B. Reduced-Pressure-Principle Backflow Preventers:
1. Manufacturers:
   a. Ames Fire & Waterworks; a division of Watts Water Technologies, Inc.
   b. Conbraco Industries, Inc.
   c. FEBCO; a division of Watts Water Technologies, Inc.
   d. Flomatic Corporation.
   e. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
   f. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.

2. Standard: ASSE 1013.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: [12 psig] <Insert value> maximum, through middle third of flow range.
5. Size: <Insert NPS>.
6. Design Flow Rate: <Insert gpm>.
7. Selected Unit Flow Range Limits: <Insert gpm>.
8. Pressure Loss at Design Flow Rate: <Insert psig> for sizes NPS 2 and smaller; <Insert psig)> for NPS 2-1/2 and larger.
9. Body: Bronze for NPS 2 and smaller; [cast iron with interior lining that complies with AWWA C550 or that is FDA approved] [steel with interior lining that complies with AWWA C550 or that is FDA approved] [stainless steel] for NPS 2-1/2 and larger.
10. End Connections: Threaded for NPS 2 and smaller; flanged <Insert type> for NPS 2-1/2 and larger.
11. Configuration: Designed for [horizontal, straight-through] [vertical-inlet, horizontal-center-section, and vertical-outlet] [vertical] <Insert configuration> flow.
12. Accessories:
    a. Valves NPS 2 and Smaller: Ball type with threaded ends on inlet and outlet.
    b. Valves NPS 2-1/2 and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.
    c. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

C. Double-Check, Backflow-Prevention Assemblies <Insert drawing designation if any>:
1. Manufacturers:
    a. Ames Fire & Waterworks; a division of Watts Water Technologies, Inc.
    b. Conbraco Industries, Inc.
    c. FEBCO; a division of Watts Water Technologies, Inc.
    d. Flomatic Corporation.
    e. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
    f. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
2. Standard: ASSE 1015.
3. Operation: Continuous-pressure applications unless otherwise indicated.
4. Pressure Loss: [5 psig] <Insert value> maximum, through middle third of flow range.
5. Size: <Insert NPS>.
6. Design Flow Rate: <Insert gpm>.
7. Selected Unit Flow Range Limits: <Insert gpm>.
8. Pressure Loss at Design Flow Rate: <Insert psig> for sizes NPS 2 and smaller; <Insert psig> for NPS 2-1/2 and larger.
9. Body: Bronze for NPS 2 and smaller; [cast iron with interior lining that complies with AWWA C550 or that is FDA approved] [steel with interior lining that complies with AWWA C550 or that is FDA approved] [stainless steel] for NPS 2-1/2 and larger.
10. End Connections: Threaded for NPS 2 and smaller; flanged <Insert type> for NPS 2-1/2 and larger.
11. Configuration: Designed for [horizontal, straight-through] <Insert configuration> flow.
12. Accessories:
    a. ValvesNPS 2 and Smaller: Ball type with threaded ends on inlet and outlet.

b. ValvesNPS 2-1/2 and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.

D. Beverage-Dispensing-Equipment Backflow Preventers:
1. Manufacturers:
a. Conbraco Industries, Inc.
b. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
c. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
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.

E. Dual-Check-Valve Backflow Preventers <Insert drawing designation if any>:
1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
2. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
a. Cash Acme; a division of Reliance Worldwide Corporation.
b. Conbraco Industries, Inc.
c. FEBCO; a division of Watts Water Technologies, Inc.
d. Flomatic Corporation.
e. Ford Meter Box Company, Inc. (The).
f. Honeywell International Inc.
g. Legend Valve.
h. McDonald, A. Y. Mfg. Co.
i. Mueller Co. Ltd.; a subsidiary of Mueller Water Products Inc.
j. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
k. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
3. Standard: ASSE 1024.
4. Operation: Continuous-pressure applications.
5. Size: [NPS 1/2] [NPS 3/4] [NPS 1] [NPS 1-1/4].
6. Body: Bronze with union inlet.

F. Carbonated-Beverage-Dispenser, Dual-Check-Valve Backflow Preventers <Insert drawing designation if any>:
1. Manufacturers:
a. Cash Acme; a division of Reliance Worldwide Corporation.
b. Lancer Corporation.
c. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
2. Standard: ASSE 1032.
3. Operation: Continuous-pressure applications.
4. Size: NPS 1/4 or NPS 3/8.

5. Body: Stainless steel.
6. End Connections: Threaded.

G. Reduced-Pressure-Detector, Fire-Protection, Backflow-Preventer Assemblies <Insert drawing designation if any>:
1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
2. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
   a. Ames Fire & Waterworks; a division of Watts Water Technologies, Inc.
   b. Conbraco Industries, Inc.
   c. FEBCO; a division of Watts Water Technologies, Inc.
   d. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
   e. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
3. Standard: ASSE 1047 and is FM Global approved or UL listed.
4. Operation: Continuous-pressure applications.
5. Pressure Loss: [12 psig] <Insert value> maximum, through middle third of flow range.
6. Size: <Insert NPS>.
7. Design Flow Rate: <Insert gpm>.
8. Selected Unit Flow Range Limits: <Insert gpm>.
9. Pressure Loss at Design Flow Rate: <Insert psig>.
10. Body: [Cast iron with interior lining that complies with AWWA C550 or that is FDA approved] [Steel with interior lining that complies with AWWA C550 or that is FDA approved] [Stainless steel].
11. End Connections: Flanged.
12. Configuration: Designed for [horizontal, straight-through] [vertical-inlet, horizontal-center-section, and vertical-outlet] [vertical] <Insert configuration> flow.
13. Accessories:
    a. Valves: Outside-screw and yoke-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.

H. Double-Check, Detector-Assembly Backflow Preventers <Insert drawing designation if any>:
1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
2. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
   a. Ames Fire & Waterworks; a division of Watts Water Technologies, Inc.
   b. Conbraco Industries, Inc.

c. FEBCO; a division of Watts Water Technologies, Inc.
d. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
e. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.

3. Standard: ASSE 1048 and is FM Global approved or UL listed.
4. Operation: Continuous-pressure applications.
5. Pressure Loss: [5 psig] <Insert value> maximum, through middle third of flow range.
6. Size: <Insert NPS>.
7. Design Flow Rate: <Insert gpm>.
8. Selected Unit Flow Range Limits: <Insert gpm>.
9. Pressure Loss at Design Flow Rate: <Insert psig>.
10. Body: [Cast iron with interior lining that complies with AWWA C550 or that is FDA approved] [Steel with interior lining that complies with AWWA C550 or that is FDA approved] [Stainless steel].
11. End Connections: Flanged.
12. Configuration: Designed for [horizontal, straight-through] [vertical-inlet, horizontal-center-section, and vertical-outlet] [vertical] <Insert configuration> flow.
13. Accessories:
    a. Valves: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.
    b. Bypass: With displacement-type water meter, shutoff valves, and reduced-pressure backflow preventer.

I. Hose-Connection Backflow Preventers:
1. Manufacturers:
    a. Conbraco Industries, Inc.
    b. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
    c. Woodford Manufacturing Company; a division of WCM Industries, Inc.
2. Standard: ASSE 1052.
3. Operation: Up to 10-foot head of water back pressure.
4. Inlet Size: NPS 1/2 or NPS 3/4.
5. Outlet Size: Garden-hose thread complying with ASME B1.20.7.
6. Capacity: At least 3-gpm flow.

J. Backflow-Preventer Test Kits <Insert drawing designation if any>:
1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
2. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
    a. Conbraco Industries, Inc.
    b. FEBCO; a division of Watts Water Technologies, Inc.
    c. Flomatic Corporation.
    d. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.

e. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.

3. Description: Factory calibrated, with gages, fittings, hoses, and carrying case with test-procedure instructions.

2.5 WATER PRESSURE-REDUCING VALVES

A. Water Regulators <Insert drawing designation if any>:

1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
2. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
   a. Cash Acme; a division of Reliance Worldwide Corporation.
   b. Conbraco Industries, Inc.
   c. Honeywell International Inc.
   d. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
   e. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
3. Standard: ASSE 1003.
4. Pressure Rating: Initial working pressure of 150 psig.
5. Size: <Insert NPS>.
6. Design Flow Rate: <Insert gpm>.
7. Design Inlet Pressure: <Insert psig>.
8. Design Outlet Pressure Setting: <Insert psig>.
9. Body: Bronze[with chrome-plated finish] for NPS 2 and smaller; cast iron[with interior lining that complies with AWWA C550 or that is FDA approved] for NPS 2-1/2 and NPS 3.
10. Valves for Booster Heater Water Supply: Include integral bypass.
11. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and NPS 3.

B. Water-Control Valves <Insert drawing designation if any>:

1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
2. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
   a. CLA-VAL.
   b. Flomatic Corporation.
   c. OCV Control Valves.
   d. Watts; a division of Watts Water Technologies, Inc.; Control Valves (Watts ACV).
   e. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
3. Description: Pilot-operated, diaphragm-type, single-seated, main water-control valve.

4. 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.
5. Main Valve Body: Cast- or ductile-iron body with AWWA C550 or FDA-approved, interior epoxy coating; or stainless-steel body.
   a. Size: <Insert NPS>.
   b. Pattern: [Angle] [Globe]-valve design.
   c. Trim: Stainless steel.
6. Design Flow: <Insert gpm>.
7. Design Inlet Pressure: <Insert psig>.
8. Design Outlet Pressure Setting: <Insert psig>.
9. End Connections: Threaded for NPS 2 and smaller; [flanged] <Insert type> for NPS 2-1/2 and larger.

2.6 BALANCING VALVES

A. Copper-Alloy Calibrated Balancing Valves:
   1. Manufacturers:
      a. Armstrong International, Inc.
      b. Flo Fab Inc.
      c. ITT Corporation; Bell & Gossett Div.
      d. NIBCO Inc.
      e. TAC.
      f. TACO Incorporated.
      g. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
   2. Type: [Ball] [or] [Y-pattern globe] valve with two readout ports and memory-setting indicator.
   3. Body: [Brass] [or] [bronze].
   4. Size: Same as connected piping, but not larger than NPS 2.
   5. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

B. Cast-Iron Calibrated Balancing Valves <Insert drawing designation if any>:
   1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
   2. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
      a. Armstrong International, Inc.
      b. Flo Fab Inc.
      c. ITT Corporation; Bell & Gossett Div.
      d. NIBCO Inc.
      e. TAC.
      f. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
   3. Type: Adjustable with Y-pattern globe valve, two readout ports, and memory-setting indicator.
   4. Size: Same as connected piping, but not smaller than NPS 2-1/2.

C. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

D. Memory-Stop Balancing Valves <Insert drawing designation if any>:
1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
2. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
   a. Conbraco Industries, Inc.
   b. Crane Co.; Crane Valve Group; Crane Valves.
   c. Crane Co.; Crane Valve Group; Jenkins Valves.
   d. Crane Co.; Crane Valve Group; Stockham Div.
   e. Hammond Valve.
   f. Milwaukee Valve Company.
   g. NIBCO Inc.
   h. Red-White Valve Corp.
3. Standard: MSS SP-110 for two-piece, copper-alloy ball valves.
4. Pressure Rating: 400-psig minimum CWP.
5. Size: NPS 2 or smaller.
6. Body: Copper alloy.
7. Port: Standard or full port.
8. Ball: Chrome-plated brass.
9. Seats and Seals: Replaceable.
10. End Connections: Solder joint or threaded.
11. Handle: Vinyl-covered steel with memory-setting device.

2.7 TEMPERATURE-ACTUATED, WATER MIXING VALVES

A. Water-Temperature Limiting Devices <Insert drawing designation if any>:
1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
2. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
   a. Armstrong International, Inc.
   b. Cash Acme; a division of Reliance Worldwide Corporation.
   c. Conbraco Industries, Inc.
   d. Honeywell International Inc.
   e. Legend Valve.
   f. Leonard Valve Company.
   g. Powers; a division of Watts Water Technologies, Inc.
   h. Symmons Industries, Inc.
   i. TACO Incorporated.
   j. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
   k. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
3. Standard: ASSE 1017.

4. Pressure Rating: 125 psig.
5. Type: Thermostatically controlled, water mixing valve.
6. Material: Bronze body with corrosion-resistant interior components.
7. Connections: Threaded[union] inlets and outlet.
8. Accessories: Check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
9. Tempered-Water Setting: <Insert deg F>.
10. Tempered-Water Design Flow Rate: <Insert gpm>.
11. Valve Finish: [Chrome plated] [Rough bronze].

B. Primary, Thermostatic, Water Mixing Valves <Insert drawing designation if any>:
1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
2. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
   a. Armstrong International, Inc.
   b. Lawler Manufacturing Company, Inc.
   c. Leonard Valve Company.
   d. Powers; a division of Watts Water Technologies, Inc.
   e. Symmons Industries, Inc.
3. Standard: ASSE 1017.
4. Pressure Rating: 125 psig minimum unless otherwise indicated.
5. Type: [Exposed-mounted] [Cabinet-type], thermostatically controlled, water mixing valve.
6. Material: Bronze body with corrosion-resistant interior components.
7. Connections: Threaded[union] inlets and outlet.
8. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
9. Tempered-Water Setting: <Insert deg F.
10. Tempered-Water Design Flow Rate: <Insert gpm.
11. Selected Valve Flow Rate at 45-psig Pressure Drop: <Insert gpm>.
12. Pressure Drop at Design Flow Rate: <Insert psig.
13. Valve Finish: [Chrome plated] [Polished, chrome plated] [Rough bronze].
14. Piping Finish: [Chrome plated] [Copper].
15. Cabinet: Factory fabricated, stainless steel, for [recessed] [surface] mounting and with hinged, stainless-steel door.

C. Manifold, Thermostatic, Water Mixing-Valve Assemblies <Insert drawing designation if any>:
1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
2. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
   a. Leonard Valve Company.
   b. Powers; a division of Watts Water Technologies, Inc.
   c. Symmons Industries, Inc.

3. Description: Factory-fabricated, [cabinet-type] [exposed-mounted], thermostatically controlled, water mixing-valve assembly in [two] [three]-valve parallel arrangement.
4. Large-Flow Parallel: Thermostatic, water mixing valve and downstream-pressure regulator with pressure gages on inlet and outlet.
5. Intermediate-Flow Parallel: Thermostatic, water mixing valve and downstream-pressure regulator with pressure gages on inlet and outlet.
6. Small-Flow Parallel: Thermostatic, water mixing valve.
7. Thermostatic Mixing Valves: Comply with ASSE 1017. Include check stops on hot- and cold-water inlets and shutoff valve on outlet.
8. Water Regulator(s): Comply with ASSE 1003. Include pressure gage on inlet and outlet.
9. Pressure Rating: 125 psig minimum unless otherwise indicated.
10. Cabinet: Factory fabricated, stainless steel, for [recessed] [surface] mounting and with hinged, stainless-steel door.
11. Selected Large-Flow, Tempered-Water Valve Size: <Insert size>.
12. Tempered-Water Setting: <Insert deg F>.
13. Unit Tempered-Water Design Flow Rate: <Insert gpm>.
14. Unit Minimum Tempered-Water Design Flow Rate: <Insert gpm>.
15. Selected Unit Flow Rate at 45-psig Pressure Drop: <Insert gpm>.
16. Unit Pressure Drop at Design Flow Rate: <Insert psig>.
17. Unit Tempered-Water Outlet Size: <Insert NPS> end connection.
18. Unit Hot- and Cold-Water Inlet Size: <Insert NPS> end connections.
19. Thermostatic Mixing Valve and Water Regulator Finish: [Chrome plated] [Polished, chrome plated] [Rough bronze].
20. Piping Finish: [Chrome plated] [Copper].

D. Photographic-Process, Thermostatic, Water Mixing-Valve Assemblies <Insert drawing designation if any>:
1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
2. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
    a. Lawler Manufacturing Company, Inc.
    b. Leonard Valve Company.
    c. Powers; a division of Watts Water Technologies, Inc.
    d. Symmons Industries, Inc.
3. Standard: ASSE 1017, thermostatically controlled, water mixing valve made for precise, process-water temperature control.
4. Pressure Rating: 125 psig minimum unless otherwise indicated.
5. Body: Bronze with corrosion-resistant interior components.
6. Connections: Threaded inlets and outlet.
7. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, thermometer, shutoff valve, and adjustable, temperature-control handle.
8. Cabinet: Factory fabricated, stainless steel, for surface mounting; with controls and thermometer mounted on front.
9. Tempered-Water Setting: <Insert deg F>.
10. Tempered-Water Design Flow Rate: <Insert gpm>.

11. Tempered-Water Outlet Size: <Insert NPS> end connection.
12. Hot- and Cold-Water Inlet Size: <Insert NPS> end connections.

E. Individual-Fixture, Water Tempering Valves:
1. Manufacturers:
a. Leonard Valve Company.
b. Powers; a division of Watts Water Technologies, Inc.
c. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
d. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
2. Standard: ASSE 1016, 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.
8. Tempered-Water Setting: <Insert deg F>.
9. Tempered-Water Design Flow Rate: <Insert gpm>.

F. Primary Water Tempering Valves <Insert drawing designation if any>:
1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
2. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
a. Heat-Timer Corporation.
b. Holby Valve Co., Inc.
3. Standard: ASSE 1017, thermostatically controlled, water tempering valve, listed as tempering valve.
4. Pressure Rating: 125 psig minimum unless otherwise indicated.
5. Body: Bronze.
6. Temperature Control: Manual.
7. Inlets and Outlet: Threaded.
8. Selected Primary Water Tempering Valve Size: <Insert size>.
9. Tempered-Water Setting: <Insert deg F>.
10. Tempered-Water Design Flow Rate: <Insert gpm>.
11. Pressure Drop at Design Flow Rate: <Insert psig>.
12. Tempered-Water Outlet Size: <Insert NPS> end connection.
13. Cold-Water Inlet Size: <Insert NPS> end connection.
14. Hot-Water Inlet Size: <Insert NPS> end connection.
15. Valve Finish: [Rough bronze] <Insert finish>.

2.8 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 that complies with AWWA C550 or that is FDA approved, epoxy coated 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] [0.033 inch] [0.062 inch] <Insert dimension>.
   b. Strainers NPS 2-1/2 to NPS 4: [0.045 inch] [0.062 inch] [0.125 inch] <Insert dimension>.
   c. Strainers NPS 5 and Larger: [0.10 inch] [0.125 inch] [0.25 inch] <Insert dimension>.
   d. Drain: [Pipe plug] [Factory-installed, hose-end drain valve].

2.9 OUTLET BOXES

A. Clothes Washer Outlet Boxes <Insert drawing designation if any>:
1. Manufacturers:
   a. Guy Gray Manufacturing Co., Inc.
   b. IPS Corporation.
   c. Oatey.
   d. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
   e. Zurn Industries, LLC; Plumbing Products Group; Light Commercial Products.
2. Mounting: Recessed.
3. Material and Finish: [Enameled-steel or epoxy-painted-steel] [Enameled-steel, epoxy-painted-steel, or plastic] [Plastic] [Stainless-steel] box and faceplate.
4. 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.
5. Supply Shutoff Fittings: NPS 1/2 gate, globe, or ball valves and NPS 1/2 copper, water tubing.
6. Drain: NPS 2 standpipe and P-trap for direct waste connection to drainage piping.
7. Inlet Hoses: Two 60-inch-long, rubber household clothes washer inlet hoses with female, garden-hose-thread couplings. Include rubber washers.
8. Drain Hose: One 48-inch-long, rubber household clothes washer drain hose with hooked end.

B. Icemaker Outlet Boxes <Insert drawing designation if any>:
1. Manufacturers:
   a. IPS Corporation.
   b. Oatey.
   c. Plastic Oddities.
2. Mounting: Recessed.
3. Material and Finish: [Enameled-steel or epoxy-painted-steel] [Enameled-steel, epoxy-painted-steel, or plastic] [Plastic] [Stainless-steel] box and faceplate.
4. Faucet: Valved fitting complying with ASME A112.18.1. Include NPS 1/2 or smaller copper tube outlet.
5. Supply Shutoff Fitting: NPS 1/2 gate, globe, or ball valve and NPS 1/2 copper, water tubing.

2.10 HOSE STATIONS

A. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

B. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
1. ARCHON Industries, Inc.
2. Armstrong International, Inc.
3. Cooney Brothers, Inc.
4. DynaFluid Ltd.
5. Leonard Valve Company.
6. Strahman Valves, Inc.
7. T & S Brass.

C. Single-Temperature-Water Hose Stations <Insert drawing designation if any>:
1. Standard: ASME A112.18.1.
2. Cabinet: Stainless-steel enclosure with exposed valve handle, hose connection, and hose rack. Include thermometer in front.
3. Hose-Rack Material: Stainless steel.
4. Body Material: Bronze[with stainless-steel wetted parts].
5. Body Finish: Rough bronze[, chrome plated].
6. Mounting: [Wall, with reinforcement] [Floor, with stainless-steel pedestal].
7. Supply Fittings: [NPS 1/2] [NPS 3/4] gate, globe, or ball valve and check valve and [NPS 1/2] [NPS 3/4] copper, water tubing. Omit check valve if check stop is included with fitting.
8. Hose: Manufacturer's standard, for service fluid, temperature, and pressure; [25 feet] [50 feet] <Insert dimension> long.
9. Nozzle: With hand-squeeze, on-off control.
10. Vacuum Breaker:
    a. Integral or factory-installed, nonremovable, manual-drain-type, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
    b. Garden-hose thread complying with ASME B1.20.7 on outlet.

D. Hot- and Cold-Water Hose Stations <Insert drawing designation if any>:
1. Standard: ASME A112.18.1.
2. Faucet Type: [Blending] [Thermostatic mixing] valve.
3. Cabinet: Stainless-steel enclosure with exposed valve handles, hose connection, and hose rack. Include thermometer in front.
4. Hose-Rack Material: Stainless steel.
5. Body Material: Bronze[with stainless-steel wetted parts].
6. Body Finish: Rough bronze[or chrome plated].
7. Mounting: [Wall, with reinforcement] [Floor, with stainless-steel pedestal].
8. Supply Fittings: Two [NPS 1/2] [NPS 3/4] gate, globe, or ball valves and check valves and [NPS 1/2] [NPS 3/4] copper, water tubing. Omit check valves if check stops are included with fitting.
9. Hose: Manufacturer's standard, for service fluid, temperature, and pressure; [25 feet] [50 feet] <Insert dimension> long.

10. Nozzle: With hand-squeeze, on-off control.
11. Vacuum Breaker: Integral or factory-installed, nonremovable, manual-drain-type, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052; and garden-hose thread complying with ASME B1.20.7 on outlet.

E. Cold-Water and Steam Hose Stations <Insert drawing designation if any>:
1. Standard: ASME A112.18.1.
2. Faucet Type: [Blending] [Thermostatic mixing] valve.
3. Cabinet: Stainless-steel enclosure with exposed valve handles, hose connection, and hose rack. Include thermometer in front.
4. Hose-Rack Material: Stainless steel.
5. Body Material: Bronze[with stainless-steel wetted parts].
6. Body Finish: Rough bronze[or chrome plated].
7. Mounting: [Wall, with reinforcement] [Floor, with stainless-steel pedestal].
8. Supply Fittings: Two [NPS 1/2] [NPS 3/4] gate, globe, or ball valves and check valves and [NPS 1/2] [NPS 3/4] copper, water tubing. Omit check valves if check stops are included with fitting.
9. Hose: Manufacturer's standard, for service fluid, temperature, and pressure; [25 feet] [50 feet] <Insert dimension> long.
10. Nozzle: With hand-squeeze, on-off control.
11. Vacuum Breaker:
    a. Integral or factory-installed, nonremovable, manual-drain-type, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
    b. Garden-hose thread complying with ASME B1.20.7 on outlet.

2.11 HOSE BIBBS

A. Hose Bibbs:
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, 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: [Rough bronze] [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] [Operating key].
13. Operation for Finished Rooms: [Wheel handle] [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.

2.12 WALL HYDRANTS

A. Nonfreeze Wall Hydrants:
1. Manufacturers:
    a. Josam Company.

b. MIFAB, Inc.
c. Prier Products, Inc.
d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
e. Watts Drainage Products.
f. Woodford Manufacturing Company; a division of WCM Industries, Inc.
g. Zurn Industries, LLC; Plumbing Products Group; Specification Drainage Products.

2. Standard: ASME A112.21.3M for concealed-outlet, self-draining wall hydrants.
3. Pressure Rating: 125 psig.
4. Operation: Loose key.
5. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
6. Inlet: NPS 3/4 or NPS 1.
7. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
8. Box: Deep, flush mounted with cover.
9. Box and Cover Finish: [Polished nickel bronze] [Chrome plated] <Insert finish>.
10. Outlet: Exposed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
11. Nozzle and Wall-Plate Finish: [Polished nickel bronze] [Rough bronze] <Insert finish>.
12. Operating Keys(s): [One] [Two] with each wall hydrant.

B. Nonfreeze, Hot- and Cold-Water Wall Hydrants if any>:
1. Manufacturers:
a. Josam Company.
b. Prier Products, Inc.
c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
d. Watts Drainage Products.
e. Woodford Manufacturing Company; a division of WCM Industries, Inc.
f. Zurn Industries, LLC; Plumbing Products Group; Specification Drainage Products.
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 Rods: Of length required to match wall thickness. Include wall clamps.
6. Inlet: NPS 3/4 or NPS 1.
7. Outlet: Concealed.
8. Box: Deep, flush mounted with cover.
9. Box and Cover Finish: [Polished nickel bronze] [Chrome plated] <Insert finish>.
10. Vacuum Breaker:
a. Nonremovable, manual-drain-type, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
b. Garden-hose thread complying with ASME B1.20.7 on outlet.
11. Operating Keys(s): [One] [Two] with each wall hydrant.

C. Moderate-Climate Wall Hydrants:
1. Manufacturers:
a. Josam Company.
b. MIFAB, Inc.
c. Prier Products, Inc.

d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
e. Watts Drainage Products.
f. Woodford Manufacturing Company; a division of WCM Industries, Inc.
g. Zurn Industries, LLC; Plumbing Products Group; Specification Drainage Products.

2. Standard: ASME A112.21.3M for concealed-outlet, self-draining wall hydrants.
3. Pressure Rating: 125 psig.
4. Operation: Loose key.
5. Inlet: NPS 3/4 or NPS 1.
6. Outlet:
   a. Concealed, with integral vacuum breaker or nonremovable hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
   b. Garden-hose thread complying with ASME B1.20.7.
7. Box: Deep, flush mounted with cover.
8. Box and Cover Finish: [Polished nickel bronze] [Chrome plated] <Insert finish>.
9. Outlet:
   a. Concealed, with integral vacuum breaker or nonremovable hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
   b. Garden-hose thread complying with ASME B1.20.7.
10. Nozzle and Wall-Plate Finish: [Polished nickel bronze] [Rough bronze] <Insert finish>.
11. Operating Keys(s): [One] [Two] with each wall hydrant.

D. Vacuum Breaker Wall Hydrants <Insert drawing designation if any>:
1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
2. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
   a. Arrowhead Brass Products.
   b. Mansfield Plumbing Products LLC.
   c. McDonald, A. Y. Mfg. Co.
   d. Prier Products, Inc.
   e. Smith, Jay. R. Mfg. Co.; Division of Smith Industries, Inc.
   f. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
   g. Woodford Manufacturing Company; a division of WCM Industries, Inc.
   h. Zurn Industries, LLC; Plumbing Products Group; Light Commercial Products.
3. Standard: ASSE 1019, Type A or Type B.
4. Type: Freeze-resistant, automatic draining with integral air-inlet valve.
5. Classification: [Type A, for automatic draining with hose removed or]Type B, for automatic draining with hose removed or with hose attached and nozzle closed.
6. Pressure Rating: 125 psig.
7. Operation: [Loose key] [or] [wheel handle].
8. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
9. Inlet: NPS 1/2 or NPS 3/4.
10. Outlet: Exposed with garden-hose thread complying with ASME B1.20.7.

2.13 GROUND HYDRANTS

A. Nonfreeze Ground Hydrants:
1. Manufacturers:
a. Josam Company.
b. MIFAB, Inc.
c. Murdock-Super Secur; a division of Acorn Engineering Company.
d. Prier Products, Inc.
e. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
f. Tyler Pipe; Wade Div.
g. Watts Drainage Products.
h. Woodford Manufacturing Company; a division of WCM Industries, Inc.
i. Zurn Industries, LLC; Plumbing Products Group; Light Commercial Products.
j. Zurn Industries, LLC; Plumbing Products Group; Specification Drainage Products.
2. Standard: ASME A112.21.3M.
3. Type: Nonfreeze, concealed-outlet ground hydrant with box.
4. Operation: Loose key.
5. Casing and Operating Rod: Of at least length required for burial of valve below frost line.
6. Inlet: NPS 3/4.
7. Outlet: Garden-hose thread complying with ASME B1.20.7.
8. Drain: Designed with hole to drain into ground when shut off.
9. Box: Standard [Deep] pattern with cover.
10. Box and Cover Finish: [Rough] [Polished nickel] <Insert finish> bronze.
11. Operating Key(s): [One] [Two] with each ground hydrant.
12. Vacuum Breaker: ASSE 1011.

2.14 POST HYDRANTS

A. Nonfreeze, Draining-Type Post Hydrants:
1. Manufacturers:
a. MIFAB, Inc.
b. Prier Products, Inc.
c. Simmons Manufacturing Co.
d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
e. Watts Drainage Products.
f. Woodford Manufacturing Company; a division of WCM Industries, Inc.
g. Zurn Industries, LLC; Plumbing Products Group; Specification Drainage Products.
2. Standard: ASME A112.21.3M.
3. Type: Nonfreeze, exposed-outlet post hydrant.
4. Operation: Loose key.
5. Casing and Operating Rod: Of at least length required for burial of valve below frost line.
6. Casing: Bronze with casing guard.
7. Inlet: NPS 3/4.
8. Outlet: Garden-hose thread complying with ASME B1.20.7.
9. Drain: Designed with hole to drain into ground when shut off.
10. Vacuum Breaker:
a. Nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.

b. Garden-hose thread complying with ASME B1.20.7 on outlet.

11. Operating Key(s): [One] [Two] with each loose-key-operation wall hydrant.

B. Nonfreeze, Nondraining-Type Post Hydrants <Insert drawing designation if any>:

1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
2. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
   a. Murdock-Super Secur; a division of Acorn Engineering Company.
   b. <Insert manufacturer's name>.
3. Operation: Lever-piston operating mechanism and nondraining water-storage reservoir, designed without drain.
4. Length: As required for burial of valve below frost line.
5. Inlet: NPS 1 threaded.
6. Outlet:
   a. NPS 1 outlet and coupling plug for 1-inch hose.
   b. NPS 1 by NPS 3/4 adapter with nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
   c. Garden-hose thread complying with ASME B1.20.7 on outlet.
   d. NPS 1 by NPS 3/4 adapter with nonremovable, drainable, hose-connection backflow preventer complying with ASSE 1052.
   e. Garden-hose thread complying with ASME B1.20.7 on outlet.

C. Freeze-Resistant Sanitary Yard Hydrants <Insert drawing designation if any>:

1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
2. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
   a. Hoeptner Products.
3. Standard: ASSE 1057, Type 5 for nondraining hydrants.
4. Operation: Wheel handle.
5. Head: Copper alloy, with pail hook.
6. Inlet: NPS 3/4-inch threaded inlet and inlet nozzle, galvanized-steel riser, and venturi.
7. Canister: [Plastic] [Zinc-plated steel] with atmospheric-vent device.
8. Vacuum Breaker:
   a. Removable hose-connection backflow preventer complying with ASSE 1052.
   b. Garden-hose thread complying with ASME B1.20.7 on outlet for field installation.

2.15 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves <Insert drawing designation if any>:

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig minimum CWP.

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

B. Gate-Valve-Type, Hose-End Drain Valves <Insert drawing designation if any>:
1. Standard: MSS SP-80 for gate valves.
2. Pressure Rating: Class 125.
3. Size: NPS 3/4.
4. Body: ASTM B 62 bronze.
5. Inlet: NPS 3/4 threaded or solder joint.
6. Outlet: Garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

C. Stop-and-Waste Drain Valves <Insert drawing designation if any>:
1. Standard: MSS SP-110 for ball valves or MSS SP-80 for gate valves.
2. Pressure Rating: 200-psig minimum CWP or Class 125.
3. Size: NPS 3/4.
4. Body: Copper alloy or ASTM B 62 bronze.
5. Drain: NPS 1/8 side outlet with cap.

2.16 WATER-HAMMER ARRESTERS

A. Water-Hammer Arresters:
1. Manufacturers:
a. Josam Company.
b. MIFAB, Inc.
c. Precision Plumbing Products, Inc.
d. Sioux Chief Manufacturing Company, Inc.
e. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
f. Watts Drainage Products.
g. Zurn Industries, LLC; Plumbing Products Group; Specification Drainage Products.
2. Standard: ASSE 1010 or PDI-WH 201.
3. Type: [Metal bellows] [Copper tube with piston].
4. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

2.17 AIR VENTS

A. Bolted-Construction Automatic Air Vents <Insert drawing designation if any>:
1. Body: Bronze.
2. Pressure Rating and Temperature: 125-psig minimum pressure rating at 140 deg F.
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Size: [NPS 3/8] [NPS 1/2] minimum inlet.
6. Inlet and Vent Outlet End Connections: Threaded.

B. Welded-Construction Automatic Air Vents <Insert drawing designation if any>:
1. Body: Stainless steel.

2. Pressure Rating: 150-psig minimum pressure rating.
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Size: NPS 3/8 minimum inlet.
6. Inlet and Vent Outlet End Connections: Threaded.

2.18 TRAP-SEAL PRIMER DEVICE

A. Supply-Type, Trap-Seal Primer Device:
1. Manufacturers:
a. MIFAB, Inc.
b. Precision Plumbing Products, Inc.
c. Sioux Chief Manufacturing Company, Inc.
d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
e. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
2. Standard: ASSE 1018.
3. Pressure Rating: 125 psig minimum.
4. Body: Bronze.
5. Inlet and Outlet Connections: NPS 1/2 threaded, union, or solder joint.
6. Gravity Drain Outlet Connection: NPS 1/2 threaded or solder joint.
7. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

B. Drainage-Type, Trap-Seal Primer Device:
1. Manufacturers:
a. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
2. Standard: ASSE 1044, lavatory P-trap with NPS 3/8 minimum, trap makeup connection.
3. Size: NPS 1-1/4 minimum.
4. Material: Chrome-plated, cast brass.

2.19 ELECTRONIC TRAP-SEAL PRIMER SYSTEMS

A. Trap-Seal Primer Systems:
1. Manufacturers:
a. Precision Plumbing Products, Inc.
2. Standard: ASSE 1044.
3. Piping: NPS 3/4, ASTM B 88, Type L; copper, water tubing.
4. Cabinet: [Recessed] [Surface]-mounted steel box with stainless-steel cover.
5. Electric Controls: 24-hour timer, solenoid valve, and manual switch for 120-V ac power.
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.
6. Vacuum Breaker: ASSE 1001.
7. Number Outlets: [Four] [Six] [Eight] <Insert number>.
8. Size Outlets: NPS 1/2.

2.20 SPECIALTY VALVES

A. Comply with requirements for general-duty metal valves in Section 220523 "General-Duty Valves for Plumbing Piping."

B. CPVC Union Ball Valves:
   1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
   2. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
      a. American Valve, Inc.
      b. Asahi/America.
      c. Colonial Engineering, Inc.
      d. Georg Fischer LLC; GF Piping Systems.
      e. Hayward Flow Control Systems; Hayward Industrial Products, Inc.
      f. IPEX.
      g. NIBCO Inc.
      h. Spears Manufacturing Company.
      i. Thermoplastic Valves Inc.
   3. Description:
      a. Standard: MSS SP-122.
      b. Pressure Rating and Temperature: [125 psig] [150 psig] <Insert value> at [73 deg F] <Insert temperature>.
      c. Body Material: CPVC.
      d. Body Design: Union type.
      e. End Connections for Valves NPS 2 and Smaller: Detachable, [socket] [or] [threaded].
      f. End Connections for Valves NPS 2-1/2 to NPS 4: Detachable, [socket] [socket or threaded] [threaded] [flanged].
      g. Ball: CPVC; full port.
      h. Seals: PTFE or EPDM-rubber O-rings.
      i. Handle: Tee shaped.

C. PVC Union Ball Valves:
   1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
   2. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
      a. American Valve, Inc.
      b. Asahi/America.
      c. Colonial Engineering, Inc.
      d. Georg Fischer LLC; GF Piping Systems.
      e. Hayward Flow Control Systems; Hayward Industrial Products, Inc.
      f. IPEX.
      g. Jomar International.
      h. KBI Company.
      i. Legend Valve.
      j. McDonald, A. Y. Mfg. Co.
      k. NIBCO Inc.
      l. Spears Manufacturing Company.
      m. Thermoplastic Valves Inc.

3. Description:
   a. Standard: MSS SP-122.
   b. Pressure Rating and Temperature: [125 psig] [150 psig] <Insert value> at [73 deg F] <Insert temperature>.
   c. Body Material: PVC.
   d. Body Design: Union type.
      e. End Connections for Valves NPS 2 and Smaller: Detachable, [socket] [or] [threaded].
      f. End Connections for Valves NPS 2-1/2 to NPS 4: Detachable, [socket] [socket or threaded] [threaded] [flanged].
      g. Ball: PVC; full port.
      h. Seals: PTFE or EPDM-rubber O-rings.
      i. Handle: Tee shaped.

D. CPVC Non-Union Ball Valves:
   1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
   2. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
      a. American Valve, Inc.
      b. Asahi/America.
      c. KBI Company.
      d. Legend Valve.
      e. NIBCO Inc.
      f. Spears Manufacturing Company.
      g. Thermoplastic Valves Inc.
   3. Description:
   4. Standard: MSS SP-122.
      a. Pressure Rating and Temperature: [125 psig] [150 psig] <Insert value> at [73 deg F] <Insert temperature>.
      b. Body Material: CPVC.
      c. Body Design: Non-union type.
      d. End Connections: Socket or threaded.
      e. Ball: CPVC; full or reduced port.
      f. Seals: PTFE or EPDM-rubber O-rings.
      g. Handle: Tee shaped.

E. PVC Non-Union Ball Valves:
   1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
   2. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
      a. American Valve, Inc.
      b. Asahi/America.
      c. Colonial Engineering, Inc.
      d. Georg Fischer LLC; GF Piping Systems.

e. Hayward Flow Control Systems; Hayward Industrial Products, Inc.
f. IPEX.
g. Jomar International.
h. KBI Company.
i. Legend Valve.
j. McDonald, A. Y. Mfg. Co.
k. NIBCO Inc.
l. Spears Manufacturing Company.
m. Thermoplastic Valves Inc.

3. Description:
   a. Standard: MSS SP-122.
   b. Pressure Rating and Temperature: [125 psig] [150 psig] <Insert value> at [73 deg F] <Insert temperature>.
   c. Body Material: PVC.
   d. Body Design: Non-union type.
   e. End Connections: Socket or threaded.
   f. Ball: PVC; full or reduced port.
   g. Seals: PTFE or EPDM-rubber O-rings.
   h. Handle: Tee shaped.

F. CPVC Butterfly Valves:
   1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
   2. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
      a. Georg Fischer LLC; GF Piping Systems.
      b. Hayward Flow Control Systems; Hayward Industrial Products, Inc.
      c. NIBCO Inc.
      d. Spears Manufacturing Company.
      e. Thermoplastic Valves Inc.
      f. Description:
      g. Pressure Rating and Temperature: [125 psig] [150 psig <Insert value> at [73 deg F] <Insert temperature>.
      h. Body Material: CPVC.
      i. Body Design: Lug or wafer type.
      j. Seat: EPDM rubber.
      k. Seals: PTFE or EPDM-rubber O-rings.
      l. Disc: CPVC.
      m. Stem: Stainless steel.
      n. Handle: Lever.

G. PVC Butterfly Valves:
   1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
   2. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer's name; product name or designation> or comparable product by one of the following:

a. American Valve, Inc.
b. Asahi/America.
c. Colonial Engineering, Inc.
d. Georg Fischer LLC; GF Piping Systems.
e. Hayward Flow Control Systems; Hayward Industrial Products, Inc.
f. IPEX.
g. Legend Valve.
h. NIBCO Inc.
i. Spears Manufacturing Company.
j. Thermoplastic Valves Inc.

3. Description:
a. Pressure Rating and Temperature: [125 psig] [150 psig] <Insert value> at [73 deg F] <Insert temperature>.
b. Body Material: PVC.
c. Body Design: Lug or wafer type.
d. Seat: EPDM rubber.
e. Seals: PTFE or EPDM-rubber O-rings.
f. Disc: PVC.
g. Stem: Stainless steel.
h. Handle: Lever.

H. CPVC Ball Check Valves:
1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
2. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
a. American Valve, Inc.
b. Asahi/America.
c. Colonial Engineering, Inc.
d. Georg Fischer LLC; GF Piping Systems.
e. Hayward Flow Control Systems; Hayward Industrial Products, Inc.
f. IPEX.
g. NIBCO Inc.
h. Spears Manufacturing Company.
i. Thermoplastic Valves Inc.
3. Description:
a. Pressure Rating and Temperature: [125 psig] [150 psig] <Insert value> at [73 deg F] <Insert temperature>.
b. Body Material: CPVC.
c. Body Design: Union-type ball check.
d. End Connections for Valves NPS 2 and Smaller: Detachable, [socket] [or] [threaded].
e. End Connections for Valves NPS 2-1/2 to NPS 4: Detachable, [socket] [socket or threaded] [threaded] [flanged].
f. Ball: CPVC.
g. Seals: EPDM- or FKM-rubber O-rings.

I. PVC Ball Check Valves:

1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
2. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
    a. American Valve, Inc.
    b. Asahi/America.
    c. Colonial Engineering, Inc.
    d. Georg Fischer LLC; GF Piping Systems.
    e. Hayward Flow Control Systems; Hayward Industrial Products, Inc.
    f. IPEX.
    g. Legend Valve.
    h. NIBCO Inc.
    i. Spears Manufacturing Company.
    j. Thermoplastic Valves Inc.
3. Description:
    a. Pressure Rating and Temperature: [125 psig] [150 psig] <Insert value> at [73 deg F] <Insert temperature>.
    b. Body Material: PVC.
    c. Body Design: Union-type ball check.
    d. End Connections for Valves NPS 2 and Smaller: Detachable, [socket] [or] [threaded].
    e. End Connections for Valves NPS 2-1/2 to NPS 4: Detachable, [socket] [socket or threaded] [threaded] [flanged].
    f. Ball: PVC.
    g. Seals: EPDM- or FKM-rubber O-rings.

J. CPVC Gate Valves:
1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
2. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
    a. Georg Fischer LLC; GF Piping Systems.
    b. Spears Manufacturing Company.
3. Description:
    a. Pressure Rating and Temperature: [125 psig] [150 psig] <Insert value> at [73 deg F] <Insert temperature>.
    b. Body Material: CPVC.
    c. Body Design: Nonrising stem.
    d. End Connections for Valves NPS 2 and Smaller: [Socket] [or] [threaded].
    e. End Connections for Valves NPS 2-1/2 to NPS 4: [Socket] [Socket or threaded] [Threaded] [Flanged].
    f. Gate and Stem: Plastic.
    g. Seals: EPDM rubber.
    h. Handle: Wheel.

K. PVC Gate Valves:
1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
2. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
    a. Asahi/America.
    b. Georg Fischer LLC; GF Piping Systems.
    c. KBI Company.
    d. Spears Manufacturing Company.
3. Description:
    a. Pressure Rating and Temperature: [125 psig] [150 psig] <Insert value> at [73 deg F] <Insert temperature>.
    b. Body Material: PVC.
    c. Body Design: Nonrising stem.
    d. End Connections for Valves NPS 2 and Smaller: [Socket] [or] [threaded].
    e. End Connections for Valves NPS 2-1/2 to NPS 4: [Socket] [Socket or threaded] [Threaded] [Flanged].
    f. Gate and Stem: Plastic.
    g. Seals: EPDM rubber.
    h. Handle: Wheel.

2.21 FLEXIBLE CONNECTORS

A. Manufacturers:
1. Flex-Hose Co., Inc.
2. Flexicraft Industries.
3. Flex Pression, Ltd.
4. Flex-Weld Incorporated.
5. Hyspan Precision Products, Inc.
6. Mercer Gasket & Shim, Inc.
7. Metraflex, Inc.
8. Proco Products, Inc.
9. TOZEN Corporation.
10. Unaflex.Universal Metal Hose; a Hyspan company.

B. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
1. Working-Pressure Rating: Minimum [200 psig] [250 psig].
2. End Connections NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.
3. End Connections NPS 2-1/2 and Larger: Flanged copper alloy.

C. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.
1. Working-Pressure Rating: Minimum [200 psig] [250 psig].
2. End Connections NPS 2 and Smaller: Threaded steel-pipe nipple.
3. End Connections NPS 2-1/2 and Larger: Flanged steel nipple.

2.22 WATER METERS

A. Displacement-Type Water Meters:
1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
2. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
    a. AALIANT; a Venture Measurement product line.ABB.Badger Meter, Inc.
    b. Carlon Meter.
    c. Mueller Co. Ltd.; a subsidiary of Mueller Water Products Inc.
    d. Schlumberger Limited; Water Services.
    e. Sensus.
3. Description:
    a. Standard: AWWA C700.
    b. Pressure Rating: 150-psig working pressure.
    c. Body Design: Nutating disc; totalization meter.
    d. Registration: In gallons or cubic feet as required by utility company.
    e. Case: Bronze.
    f. End Connections: Threaded.

B. Turbine-Type Water Meters:
1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
2. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
    a. AALIANT; a Venture Measurement product line.
    b. ABB.
    c. Badger Meter, Inc.
    d. Hays Fluid Controls.
    e. Master Meter, Inc.
    f. McCrometer, Inc.
    g. Mueller Co. Ltd.; a subsidiary of Mueller Water Products Inc.
    h. Schlumberger Limited; Water Services.
    i. SeaMetrics Inc.
    j. Sensus.
3. Description:
    a. Standard: AWWA C701.
    b. Pressure Rating: [150-psig] <Insert value> working pressure.
    c. Body Design: Turbine; totalization meter.
    d. Registration: In gallons or cubic feet as required by utility company.
    e. Case: Bronze.
    f. End Connections for Meters NPS 2 and Smaller: Threaded.
    g. End Connections for Meters NPS 2-1/2 and Larger: Flanged.

C. Compound-Type Water Meters:
   1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
   2. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
      a. ABB.
      b. Badger Meter, Inc.
      c. Master Meter, Inc.
      d. Mueller Co. Ltd.; a subsidiary of Mueller Water Products Inc.
      e. Schlumberger Limited; Water Services.
      f. Sensus.
   3. Description:
      a. Standard: AWWA C702.
      b. Pressure Rating: 150-psig working pressure.
      c. Body Design: With integral mainline and bypass meters; totalization meter.
      d. Registration: In gallons or cubic feet as required by utility company.
      e. Case: Bronze.
      f. Pipe Connections: Flanged.

D. Remote Registration System: Direct-reading type complying with AWWA C706; modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly as required by utility company.

E. Remote Registration System: Encoder type complying with AWWA C707; modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly as required by utility company.

PART 3 - EXECUTION

3.1 INSTALLATION

A. 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 unacceptable for this application.
   3. Do not install bypass piping around backflow preventers.

B. Install water regulators with inlet and outlet shutoff valves [and bypass with memory-stop balancing valve]. Install pressure gages on inlet and outlet.

C. Install water-control valves with inlet and outlet shutoff valves [and bypass with globe valve]. Install pressure gages on inlet and outlet.

D. Install balancing valves in locations where they can easily be adjusted.

E. Install temperature-actuated, water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.
   1. Install cabinet-type units recessed in or surface mounted on wall as specified.
   2. Install Y-pattern strainers for water on supply side of each [control valve] [water pressure-reducing valve] [solenoid valve] [and] [pump].

F. Install outlet boxes recessed in wall or surface mounted on wall. Install 2-by-4-inch fire-retardant-treated-wood blocking, wall reinforcement between studs. Comply with requirements for fire-retardant-treated-wood blocking in Section 061000 "Rough Carpentry."

G. Install hose stations with check stops or shutoff valves on inlets and with thermometer on outlet.
   1. Install cabinet-type units recessed in or surface mounted on wall as specified. Install 2-by-4-inch fire-retardant-treated-wood blocking, wall reinforcement between studs. Comply with requirements for fire-retardant-treated-wood blocking in Section 061000 "Rough Carpentry."

H. Install ground hydrants with 1 cu. yd. of crushed gravel around drain hole. Set ground hydrants with box flush with grade.

I. Install draining-type post hydrants with 1 cu. yd. of crushed gravel around drain hole. Set post hydrants in concrete paving or in 1 cu. ft. of concrete block at grade.

J. Set nonfreeze, nondraining-type post hydrants in concrete or pavement.

K. Set freeze-resistant yard hydrants with riser pipe in concrete or pavement. Do not encase canister in concrete.

L. Install water-hammer arresters in water piping according to PDI-WH 201.

M. Install air vents at high points of water piping. [Install drain piping and discharge onto floor drain.]

N. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.

O. Install drainage-type, trap-seal primer valves as lavatory trap with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.

P. Install trap-seal primer systems with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust system for proper flow.

3.2 CONNECTIONS

A. Comply with requirements for ground equipment in Section 260526 "Grounding and Bonding for Electrical Systems."

B. Fire-retardant-treated-wood blocking is specified in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for electrical connections.

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. Intermediate atmospheric-vent backflow preventers.
3. Reduced-pressure-principle backflow preventers.
4. Double-check, backflow-prevention assemblies.
5. Carbonated-beverage-machine backflow preventers.
6. Dual-check-valve backflow preventers.
7. Reduced-pressure-detector, fire-protection, backflow-preventer assemblies.
8. Double-check, detector-assembly backflow preventers.
9. Water pressure-reducing valves.
10. Calibrated balancing valves.
11. Primary, thermostatic, water mixing valves.
12. Manifold, thermostatic, water mixing-valve assemblies.
13. Photographic-process, thermostatic, water mixing-valve assemblies.
14. Primary water tempering valves.
15. Outlet boxes.
16. Hose stations.
17. Supply-type, trap-seal primer valves.
18. Trap-seal primer systems.

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 Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
1. Test each [pressure vacuum breaker] [reduced-pressure-principle backflow preventer] [double-check, backflow-prevention assembly] [and] [double-check, detector-assembly backflow preventer] <Insert type> according to authorities having jurisdiction and the device's reference standard.

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

C. Prepare test and inspection reports.

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 221119 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Vacuum breakers.
   2. Backflow preventers.
   3. Balancing valves.
   4. Temperature-actuated, water mixing valves.
   5. Strainers.
   6. Outlet boxes.
   7. Hose bibbs.
   8. Wall hydrants.
   9. Ground hydrants.
   10. Post hydrants.
   11. Water-hammer arresters.
   12. Trap-seal primer valves.
   13. Trap-seal primer systems.
   14. Specialty valves.
   15. Flexible connectors.

B. Related Requirements:
   1. Section 220519 "Meters and Gages for Plumbing Piping" for thermometers, pressure gages, and flow meters in domestic water piping.
   2. Section 221116 "Domestic Water Piping" for water meters.
   3. Section 223200 "Domestic Water Filtration Equipment" for water filters in domestic water piping.
   4. Section 224300 "Medical Plumbing Fixtures" for thermostatic mixing valves for sitz baths, thermostatic mixing-valve assemblies for hydrotherapy equipment, and outlet boxes for dialysis equipment.
   5. Section 224500 "Emergency Plumbing Fixtures" for water tempering equipment.
   6. Section 224713 "Drinking Fountains" for water filters for water coolers.
   7. Section 224716 "Pressure Water Coolers" for water filters for water coolers.
   8. Section 224723 "Remote Water Coolers" for water filters for water coolers.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For domestic water piping specialties.
   1. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

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

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

A. Potable-water piping and components shall comply with NSF 61[and NSF 14].[Mark "NSF-pw" on plastic piping components.]

2.2 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: [125 psig] <Insert value> unless otherwise indicated.

2.3 VACUUM BREAKERS

A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:
   1. Manufacturers:
      a. Ames Fire & Waterworks; a division of Watts Water Technologies, Inc.
      b. Cash Acme; a division of Reliance Worldwide Corporation.
      c. Conbraco Industries, Inc.
      d. FEBCO; a division of Watts Water Technologies, Inc.
      e. Rain Bird Corporation.
      f. Toro Company (The); Irrigation Div.
      g. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
      h. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
   2. Standard: ASSE 1001.
   3. Size: NPS 1/4 to NPS 3, as required to match connected piping.
   4. Body: Bronze.
   5. Inlet and Outlet Connections: Threaded.
   6. Finish: [Rough bronze] [Chrome plated].

B. Hose-Connection Vacuum Breakers:
   1. Manufacturers:
      a. Arrowhead Brass Products.
      b. Cash Acme; a division of Reliance Worldwide Corporation.
      c. Conbraco Industries, Inc.
      d. Legend Valve.
      e. MIFAB, Inc.
      f. Prier Products, Inc.
      g. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
      h. Woodford Manufacturing Company; a division of WCM Industries, Inc.
      i. Zurn Industries, LLC; Plumbing Products Group; Light Commercial Products.
      j. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
   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] [Rough bronze].

2.4 BACKFLOW PREVENTERS

A. Intermediate Atmospheric-Vent Backflow Preventers:
   1. Manufacturers:
      a. Cash Acme; a division of Reliance Worldwide Corporation.
      b. Conbraco Industries, Inc.
      c. FEBCO; a division of Watts Water Technologies, Inc.
      d. Honeywell International Inc.
      e. Legend Valve.
      f. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
      g. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
   2. Standard: ASSE 1012.
   3. Operation: Continuous-pressure applications.
   4. Body: Bronze.
   5. End Connections: [Union, solder] [Solder] joint.
   6. Finish: Rough bronze.

B. Reduced-Pressure-Principle Backflow Preventers:
   1. Manufacturers:
      a. Ames Fire & Waterworks; a division of Watts Water Technologies, Inc.
      b. Conbraco Industries, Inc.
      c. FEBCO; a division of Watts Water Technologies, Inc.
      d. Flomatic Corporation.
      e. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.

f. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
2. Standard: ASSE 1013.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: [12 psig] <Insert value> maximum, through middle third of flow range.
5. Pressure Loss at Design Flow Rate: <Insert psig> for sizes NPS 2 and smaller; <Insert psig)> for NPS 2-1/2 and larger.
6. Body: Bronze for NPS 2 and smaller; [cast iron with interior lining that complies with AWWA C550 or that is FDA approved] [steel with interior lining that complies with AWWA C550 or that is FDA approved] [stainless steel] for NPS 2-1/2 and larger.
7. End Connections: Threaded for NPS 2 and smaller; [flanged] <Insert type> for NPS 2-1/2 and larger.
8. Configuration: Designed for [horizontal, straight-through] [vertical-inlet, horizontal-center-section, and vertical-outlet] [vertical] <Insert configuration> flow.
9. Accessories:
   a. Valves NPS 2 and Smaller: Ball type with threaded ends on inlet and outlet.
   b. Valves NPS 2-1/2 and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.
   c. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

C. Double-Check, Backflow-Prevention Assemblies
1. Manufacturers:
   a. Ames Fire & Waterworks; a division of Watts Water Technologies, Inc.
   b. Conbraco Industries, Inc.
   c. FEBCO; a division of Watts Water Technologies, Inc.
   d. Flomatic Corporation.
   e. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
   f. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
   g. <Insert manufacturer's name>.
2. Standard: ASSE 1015.
3. Operation: Continuous-pressure applications unless otherwise indicated.
4. Pressure Loss: [5 psig] <Insert value> maximum, through middle third of flow range.
5. Design Flow Rate: <Insert gpm>.
6. Selected Unit Flow Range Limits: <Insert gpm>.
7. Pressure Loss at Design Flow Rate: <Insert psig> for sizes NPS 2 and smaller; <Insert psig> for NPS 2-1/2 and larger.
8. Body: Bronze for NPS 2 and smaller; [cast iron with interior lining that complies with AWWA C550 or that is FDA approved] [steel with interior lining that complies with AWWA C550 or that is FDA approved] [stainless steel] for NPS 2-1/2 and larger.
9. End Connections: Threaded for NPS 2 and smaller; [flanged] <Insert type> for NPS 2-1/2 and larger.
10. Configuration: Designed for [horizontal, straight-through] <Insert configuration> flow.
11. Accessories:
    a. ValvesNPS 2 and Smaller: Ball type with threaded ends on inlet and outlet.
    b. ValvesNPS 2-1/2 and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.

D. Beverage-Dispensing-Equipment Backflow Preventers:
1. Manufacturers:
   a. Conbraco Industries, Inc.
   b. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
   c. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
   d. <Insert manufacturer's name>.
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.

E. Hose-Connection Backflow Preventers:
1. Manufacturers:
   a. Conbraco Industries, Inc.

b. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
c. Woodford Manufacturing Company; a division of WCM Industries, Inc.
d. <Insert manufacturer's name>.

2. Standard: ASSE 1052.
3. Operation: Up to 10-foot head of water back pressure.
4. Inlet Size: NPS 1/2 or NPS 3/4.
5. Outlet Size: Garden-hose thread complying with ASME B1.20.7.
6. Capacity: At least 3-gpm flow.

2.5 WATER PRESSURE-REDUCING VALVES

A. Water Regulators:

1. Manufacturers:
   a. Cash Acme; a division of Reliance Worldwide Corporation.
   b. Conbraco Industries, Inc.
   c. Honeywell International Inc.
   d. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
   e. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
   f. <Insert manufacturer's name>.
2. Standard: ASSE 1003.
3. Pressure Rating: Initial working pressure of 150 psig.
4. Design Outlet Pressure Setting: <Insert psig>.
5. Body: Bronze[with chrome-plated finish] for NPS 2 and smaller; cast iron[with interior lining that complies with AWWA C550 or that is FDA approved] for NPS 2-1/2 and NPS 3.
6. Valves for Booster Heater Water Supply: Include integral bypass.
7. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and NPS 3.

2.6 BALANCING VALVES

A. Copper-Alloy Calibrated Balancing Valves:

1. Manufacturers:
   a. Armstrong International, Inc.
   b. Flo Fab Inc.
   c. ITT Corporation; Bell & Gossett Div.
   d. NIBCO Inc.
   e. TAC.
   f. TACO Incorporated.
   g. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
2. Type: [Ball] [or] [Y-pattern globe] valve with two readout ports and memory-setting indicator.
3. Body: [Brass] [or] [bronze].
4. Size: Same as connected piping, but not larger than NPS 2.
5. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

B. Cast-Iron Calibrated Balancing Valves:

1. Manufacturers:
   a. Armstrong International, Inc.
   b. Flo Fab Inc.
   c. ITT Corporation; Bell & Gossett Div.
   d. NIBCO Inc.
   e. TAC.
   f. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
2. Type: Adjustable with Y-pattern globe valve, two readout ports, and memory-setting indicator.
3. Size: Same as connected piping, but not smaller than NPS 2-1/2.

C. Memory-Stop Balancing Valves :

1. Manufacturers:
   a. Conbraco Industries, Inc.
   b. Crane Co.; Crane Valve Group; Crane Valves.
   c. Crane Co.; Crane Valve Group; Jenkins Valves.
   d. Crane Co.; Crane Valve Group; Stockham Div.

e. Hammond Valve.
f. Milwaukee Valve Company.
g. NIBCO Inc.
h. Red-White Valve Corp.
i. <Insert manufacturer's name>.

2. Standard: MSS SP-110 for two-piece, copper-alloy ball valves.
3. Pressure Rating: 400-psig minimum CWP.
4. Size: NPS 2 or smaller.
5. Body: Copper alloy.
6. Port: Standard or full port.
7. Ball: Chrome-plated brass.
8. Seats and Seals: Replaceable.
9. End Connections: Solder joint or threaded.
10. Handle: Vinyl-covered steel with memory-setting device.

2.7 TEMPERATURE-ACTUATED, WATER MIXING VALVES

A. Individual-Fixture, Water Tempering Valves <Insert drawing designation if any>:

1. Manufacturers:
   a. Cash Acme; a division of Reliance Worldwide Corporation.
   b. Conbraco Industries, Inc.
   c. Honeywell International Inc.
   d. Lawler Manufacturing Company, Inc.
   e. Leonard Valve Company.
   f. Powers; a division of Watts Water Technologies, Inc.
   g. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
   h. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
2. Standard: ASSE 1016, 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.
8. Tempered-Water Setting: <Insert deg F>.
9. Tempered-Water Design Flow Rate: <Insert gpm>.

2.8 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers <Insert drawing designation if any>:

1. Pressure Rating: 125 psig minimum unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller; cast iron[with interior lining that complies with AWWA C550 or that is FDA approved, epoxy coated and] for NPS 2-1/2 and larger.
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] [0.033 inch] [0.062 inch] <Insert dimension>.
   b. Strainers NPS 2-1/2 to NPS 4: [0.045 inch] [0.062 inch] [0.125 inch] <Insert dimension>.
   c. Strainers NPS 5 and Larger: [0.10 inch] [0.125 inch] [0.25 inch] <Insert dimension>.
6. Drain: [Pipe plug] [Factory-installed, hose-end drain valve].

2.9 OUTLET BOXES

A. Clothes Washer Outlet Boxes:

1. Manufacturers:
   a. Acorn Engineering Company.
   b. Guy Gray Manufacturing Co., Inc.
   c. IPS Corporation.
   d. LSP Products Group, Inc.
   e. Oatey.
   f. Plastic Oddities.
   g. Symmons Industries, Inc.

h. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
i. Whitehall Manufacturing; a div. of Acorn Engineering Company.
j. Zurn Industries, LLC; Plumbing Products Group; Light Commercial Products.

2. Mounting: Recessed.
3. Material and Finish: [Enameled-steel or epoxy-painted-steel] [Enameled-steel, epoxy-painted-steel, or plastic] [Plastic] [Stainless-steel] box and faceplate.
4. 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.
5. Supply Shutoff Fittings: NPS 1/2 gate, globe, or ball valves and NPS 1/2 copper, water tubing.
6. Drain: [NPS 1-1/2] [NPS 2] standpipe and P-trap for direct waste connection to drainage piping.
7. Inlet Hoses: Two 60-inch-long, rubber household clothes washer inlet hoses with female, garden-hose-thread couplings. Include rubber washers.
8. Drain Hose: One 48-inch-long, rubber household clothes washer drain hose with hooked end.

B. Icemaker Outlet Boxes:
1. Manufacturers:
a. Acorn Engineering Company.
b. IPS Corporation.
c. LSP Products Group, Inc.
d. Oatey.
e. Plastic Oddities.
2. Mounting: Recessed.
3. Material and Finish: [Enameled-steel or epoxy-painted-steel] [Enameled-steel, epoxy-painted-steel, or plastic] [Plastic] [Stainless-steel] box and faceplate.
4. Faucet: Valved fitting complying with ASME A112.18.1. Include NPS 1/2 or smaller copper tube outlet.
5. Supply Shutoff Fitting: NPS 1/2 gate, globe, or ball valve and NPS 1/2 copper, water tubing.

2.10 HOSE STATIONS
A. Manufacturers:
1. ARCHON Industries, Inc.
2. Armstrong International, Inc.
3. Cooney Brothers, Inc.
4. DynaFluid Ltd.
5. Leonard Valve Company.
6. Strahman Valves, Inc.
7. T & S Brass.

B. Single-Temperature-Water Hose Stations:
1. Standard: ASME A112.18.1.
2. Cabinet: Stainless-steel enclosure with exposed valve handle, hose connection, and hose rack. Include thermometer in front.
3. Hose-Rack Material: Stainless steel.
4. Body Material: Bronze[with stainless-steel wetted parts].
5. Body Finish: Rough bronze[, chrome plated].
6. Mounting: [Wall, with reinforcement] [Floor, with stainless-steel pedestal].
7. Supply Fittings: [NPS 1/2] [NPS 3/4] gate, globe, or ball valve and check valve and [NPS 1/2] [NPS 3/4] copper, water tubing. Omit check valve if check stop is included with fitting.
8. Hose: Manufacturer's standard, for service fluid, temperature, and pressure; [25 feet] [50 feet] <Insert dimension> long.
9. Nozzle: With hand-squeeze, on-off control.
10. Vacuum Breaker:

a. Integral or factory-installed, nonremovable, manual-drain-type, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
b. Garden-hose thread complying with ASME B1.20.7 on outlet.

2.11 HOSE BIBBS

A. Hose Bibbs:
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: [Rough bronze] [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] [Operating key].
13. Operation for Finished Rooms: [Wheel handle] [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.

2.12 WALL HYDRANTS

A. Nonfreeze Wall Hydrants:
1. Manufacturers:
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.
g. Woodford Manufacturing Company; a division of WCM Industries, Inc.
h. Zurn Industries, LLC; Plumbing Products Group; Light Commercial Products.
i. Zurn Industries, LLC; Plumbing Products Group; Specification Drainage Products.
2. Standard: ASME A112.21.3M for [concealed] [exposed]-outlet, self-draining wall hydrants.
3. Pressure Rating: 125 psig.
4. Operation: Loose key.
5. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
6. Inlet: NPS 3/4 or NPS 1.
7. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
8. Box: Deep, flush mounted with cover.
9. Box and Cover Finish: [Polished nickel bronze] [Chrome plated] <Insert finish>.
10. Outlet: Exposed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
11. Nozzle and Wall-Plate Finish: [Polished nickel bronze] [Rough bronze] <Insert finish>.
12. Operating Keys(s): [One] [Two] with each wall hydrant.

2.13 GROUND HYDRANTS

A. Nonfreeze Ground Hydrants:
1. Manufacturers:
a. Josam Company.
b. MIFAB, Inc.
c. Murdock-Super Secur; a division of Acorn Engineering Company.

d. Prier Products, Inc.
e. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
f. Tyler Pipe; Wade Div.
g. Watts Drainage Products.
h. Woodford Manufacturing Company; a division of WCM Industries, Inc.
i. Zurn Industries, LLC; Plumbing Products Group; Light Commercial Products.
j. Zurn Industries, LLC; Plumbing Products Group; Specification Drainage Products.
k. <Insert manufacturer's name>.

2. Standard: ASME A112.21.3M.
3. Type: Nonfreeze, concealed-outlet ground hydrant with box.
4. Operation: Loose key.
5. Casing and Operating Rod: Of at least length required for burial of valve below frost line.
6. Inlet: NPS 3/4.
7. Outlet: Garden-hose thread complying with ASME B1.20.7.
8. Drain: Designed with hole to drain into ground when shut off.
9. Box: [Standard] [Deep] pattern with cover.
10. Box and Cover Finish: [Rough] [Polished nickel] <Insert finish> bronze.
11. Operating Key(s): [One] [Two] with each ground hydrant.
12. Vacuum Breaker: ASSE 1011.

2.14 POST HYDRANTS

A. Nonfreeze, Draining-Type Post Hydrants:

1. Manufacturers:
   a. MIFAB, Inc.
   b. Prier Products, Inc.
   c. Simmons Manufacturing Co.
   d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   e. Tyler Pipe; Wade Div.
   f. Watts Drainage Products.
   g. Woodford Manufacturing Company; a division of WCM Industries, Inc.
   h. Zurn Industries, LLC; Plumbing Products Group; Light Commercial Products.
   i. Zurn Industries, LLC; Plumbing Products Group; Specification Drainage Products.
   j. <Insert manufacturer's name>.
2. Standard: ASME A112.21.3M.
3. Type: Nonfreeze, exposed-outlet post hydrant.
4. Operation: Loose key.
5. Casing and Operating Rod: Of at least length required for burial of valve below frost line.
6. Casing: Bronze with casing guard.
7. Inlet: NPS 3/4.
8. Outlet: Garden-hose thread complying with ASME B1.20.7.
9. Drain: Designed with hole to drain into ground when shut off.
10. Vacuum Breaker:
    a. Nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
    b. Garden-hose thread complying with ASME B1.20.7 on outlet.
11. Operating Key(s): [One] [Two] with each loose-key-operation wall hydrant.

2.15 WATER-HAMMER ARRESTERS

A. Water-Hammer Arresters:

1. Manufacturers:
   a. AMTROL, Inc.
   b. Josam Company.
   c. MIFAB, Inc.
   d. Precision Plumbing Products, 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.
i. Zurn Industries, LLC; Plumbing Products Group; Specification Drainage Products.
2. Standard: ASSE 1010 or PDI-WH 201.
3. Type: [Metal bellows] [Copper tube with piston].
4. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

2.16 TRAP-SEAL PRIMER DEVICE

A. Supply-Type, Trap-Seal Primer Device:
1. Manufacturers:
a. MIFAB, Inc.
b. Precision Plumbing Products, Inc.
c. Sioux Chief Manufacturing Company, Inc.
d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
e. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
2. Standard: ASSE 1018.
3. Pressure Rating: 125 psig minimum.
4. Body: Bronze.
5. Inlet and Outlet Connections: NPS 1/2 threaded, union, or solder joint.
6. Gravity Drain Outlet Connection: NPS 1/2 threaded or solder joint.
7. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

B. Drainage-Type, Trap-Seal Primer Device:
1. Manufacturers:
a. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
2. Standard: ASSE 1044, lavatory P-trap with NPS 3/8 minimum, trap makeup connection.
3. Size: NPS 1-1/4 minimum.
4. Material: Chrome-plated, cast brass.

2.17 TRAP-SEAL PRIMER SYSTEMS

A. Trap-Seal Primer Systems:
1. Manufacturers:
a. Precision Plumbing Products, Inc.
2. Standard: ASSE 1044.
3. Piping: NPS 3/4, ASTM B 88, Type L; copper, water tubing.
4. Cabinet: [Recessed] [Surface]-mounted steel box with stainless-steel cover.
5. Electric Controls: 24-hour timer, solenoid valve, and manual switch for 120-V ac power.
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.
6. Vacuum Breaker: ASSE 1001.
7. Number Outlets: [Four] [Six] [Eight] <Insert number>.
8. Size Outlets: [NPS 1/2] [NPS 5/8].

2.18 SPECIALTY VALVES

A. Comply with requirements for general-duty metal valves in Section 220523 "General-Duty Valves for Plumbing Piping."

B. CPVC Union Ball Valves:
1. Manufacturers:
a. American Valve, Inc.
b. Asahi/America.
c. Colonial Engineering, Inc.
d. Georg Fischer LLC; GF Piping Systems.
e. Hayward Flow Control Systems; Hayward Industrial Products, Inc.
f. IPEX.
g. NIBCO Inc.
h. Spears Manufacturing Company.
i. Thermoplastic Valves Inc.

2. Description:
   a. Standard: MSS SP-122.
   b. Pressure Rating and Temperature: [125 psig] [150 psig] <Insert value> at [73 deg F] <Insert temperature>.
   c. Body Material: CPVC.
   d. Body Design: Union type.
   e. End Connections for Valves NPS 2 and Smaller: Detachable, [socket] [or] [threaded].
   f. End Connections for Valves NPS 2-1/2 to NPS 4: Detachable, [socket] [socket or threaded] [threaded] [flanged].
   g. Ball: CPVC; full port.
   h. Seals: PTFE or EPDM-rubber O-rings.
   i. Handle: Tee shaped.

C. CPVC Non-Union Ball Valves:
1. Manufacturers:
   a. American Valve, Inc.
   b. Asahi/America.
   c. KBI Company.
   d. Legend Valve.
   e. NIBCO Inc.
   f. Spears Manufacturing Company.
   g. Thermoplastic Valves Inc.
2. Description:
   a. Standard: MSS SP-122.
   b. Pressure Rating and Temperature: [125 psig] [150 psig] <Insert value> at [73 deg F]
   c. Body Material: CPVC.
   d. Body Design: Non-union type.
   e. End Connections: Socket or threaded.
   f. Ball: CPVC; full or reduced port.
   g. Seals: PTFE or EPDM-rubber O-rings.
   h. Handle: Tee shaped.

D. CPVC Butterfly Valves:
1. Manufacturers:
   a. Georg Fischer LLC; GF Piping Systems.
   b. Hayward Flow Control Systems; Hayward Industrial Products, Inc.
   c. NIBCO Inc.
   d. Spears Manufacturing Company.
   e. Thermoplastic Valves Inc.
2. Description:
   a. Pressure Rating and Temperature: [125 psig] [150 psig <Insert value> at [73 deg F] <Insert temperature>.
   b. Body Material: CPVC.
   c. Body Design: Lug or wafer type.
   d. Seat: EPDM rubber.
   e. Seals: PTFE or EPDM-rubber O-rings.
   f. Disc: CPVC.
   g. Stem: Stainless steel.
   h. Handle: Lever.

E. CPVC Ball Check Valves:
1. Manufacturers:
   a. American Valve, Inc.
   b. Asahi/America.
   c. Colonial Engineering, Inc.
   d. Georg Fischer LLC; GF Piping Systems.
   e. Hayward Flow Control Systems; Hayward Industrial Products, Inc.
   f. IPEX.
   g. NIBCO Inc.
   h. Spears Manufacturing Company.

i. Thermoplastic Valves Inc.

2. Description:
   a. Pressure Rating and Temperature: [125 psig] [150 psig] <Insert value> at [73 deg F] <Insert temperature>.
   b. Body Material: CPVC.
   c. Body Design: Union-type ball check.
   d. End Connections for Valves NPS 2 and Smaller: Detachable, [socket] [or] [threaded].
   e. End Connections for Valves NPS 2-1/2 to NPS 4: Detachable, [socket] [socket or threaded] [threaded] [flanged].
   f. Ball: CPVC.
   g. Seals: EPDM- or FKM-rubber O-rings.

F. CPVC Gate Valves:
1. Manufacturers:
   a. Georg Fischer LLC; GF Piping Systems.
   b. Spears Manufacturing Company.
2. Description:
   a. Pressure Rating and Temperature: [125 psig] [150 psig] <Insert value> at [73 deg F] <Insert temperature>.
   b. Body Material: CPVC.
   c. Body Design: Nonrising stem.
   d. End Connections for Valves NPS 2 and Smaller: [Socket] [or] [threaded].
   e. End Connections for Valves NPS 2-1/2 to NPS 4: [Socket] [Socket or threaded] [Threaded] [Flanged].
   f. Gate and Stem: Plastic.
   g. Seals: EPDM rubber.
   h. Handle: Wheel.

2.19 FLEXIBLE CONNECTORS

A. Manufacturers:
1. Flex-Hose Co., Inc.
2. Flexicraft Industries.
3. Flex Pression, Ltd.
4. Flex-Weld Incorporated.
5. Hyspan Precision Products, Inc.
6. Mercer Gasket & Shim, Inc.
7. Metraflex, Inc.
8. Proco Products, Inc.
9. TOZEN Corporation.
10. Unaflex.Universal Metal Hose; a Hyspan company.

B. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.
1. Working-Pressure Rating: Minimum [200 psig] [250 psig].
2. End Connections NPS 2 and Smaller: Threaded steel-pipe nipple.
3. End Connections NPS 2-1/2 and Larger: Flanged steel nipple.

PART 3 - EXECUTION

3.1 INSTALLATION

A. 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 unacceptable for this application.
3. Do not install bypass piping around backflow preventers.

B. Install water-control valves with inlet and outlet shutoff valves [and bypass with globe valve]. Install pressure gages on inlet and outlet.
C. Install balancing valves in locations where they can easily be adjusted.
D. Install temperature-actuated, water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.
   1. Install cabinet-type units recessed in or surface mounted on wall as specified.
E. Install Y-pattern strainers for water on supply side of each [control valve] [water pressure-reducing valve] [solenoid valve] [and] [pump].
F. Install outlet boxes recessed in wall or surface mounted on wall. Install 2-by-4-inch fire-retardant-treated-wood blocking, wall reinforcement between studs. Comply with requirements for fire-retardant-treated-wood blocking in Section 061000 "Rough Carpentry."
G. Install hose stations with check stops or shutoff valves on inlets and with thermometer on outlet.
   1. Install cabinet-type units recessed in or surface mounted on wall as specified. Install 2-by-4-inch fire-retardant-treated-wood blocking, wall reinforcement between studs. Comply with requirements for fire-retardant-treated-wood blocking in Section 061000 "Rough Carpentry."
H. Install ground hydrants with [1 cu. yd.] <Insert dimension> of crushed gravel around drain hole. Set ground hydrants with box flush with grade.
I. Install draining-type post hydrants with [1 cu. yd.] <Insert dimension> of crushed gravel around drain hole. Set post hydrants in concrete paving or in [1 cu. ft.] <Insert dimension> of concrete block at grade.
J. Set nonfreeze, nondraining-type post hydrants in concrete or pavement.
K. Set freeze-resistant yard hydrants with riser pipe in concrete or pavement. Do not encase canister in concrete.
L. Install water-hammer arresters in water piping according to PDI-WH 201.
M. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.
N. Install drainage-type, trap-seal primer valves as lavatory trap with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.
O. Install trap-seal primer systems with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust system for proper flow.

3.2 CONNECTIONS
A. Comply with requirements for ground equipment in Section 260526 "Grounding and Bonding for Electrical Systems."
B. Fire-retardant-treated-wood blocking is specified in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for electrical connections.

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. Intermediate atmospheric-vent backflow preventers.
   3. Reduced-pressure-principle backflow preventers.
   4. Double-check, backflow-prevention assemblies.
   5. Carbonated-beverage-machine backflow preventers.
   6. Dual-check-valve backflow preventers.
   7. Reduced-pressure-detector, fire-protection, backflow-preventer assemblies.
   8. Double-check, detector-assembly backflow preventers.
   9. Water pressure-reducing valves.
   10. Calibrated balancing valves.
   11. Primary, thermostatic, water mixing valves.
   12. Manifold, thermostatic, water mixing-valve assemblies.
   13. Photographic-process, thermostatic, water mixing-valve assemblies.

14. Primary water tempering valves.
15. Outlet boxes.
16. Hose stations.
17. Supply-type, trap-seal primer valves.
18. Trap-seal primer systems.

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 Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
   1. Test each [pressure vacuum breaker] [reduced-pressure-principle backflow preventer] [double-check, backflow-prevention assembly] [and] [double-check, detector-assembly backflow preventer] <Insert type> according to authorities having jurisdiction and the device's reference standard.

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

C. Prepare test and inspection reports.

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 221120 – FACILITY PROPANE GAS PIPING

PART 1 - GENERAL

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.

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. Service meters.
      7. Mechanical sleeve seals.
      8. Grout.
      9. Concrete bases.

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.

4. PERFORMANCE REQUIREMENTS

   A. Minimum Operating-Pressure Ratings:
      1. Piping and Valves: 100 psig (690 kPa) minimum unless otherwise indicated.
      2. Service Regulators: 65 psig (450 kPa) minimum unless otherwise indicated.
      3. Minimum Operating Pressure of Service Meter: 5 psig (34.5 kPa).

   B. Propane Gas System Pressure within Buildings: 0.5 psig (3.45 kPa) or less.

5. SUBMITTALS

   A. Product Data: For each type of the following:
      1. Piping specialties.
      2. Corrugated, stainless-steel tubing with associated components.
      3. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.

4. Pressure regulators. Indicate pressure ratings and capacities.
5. Dielectric fittings.
6. Mechanical sleeve seals.
7. Escutcheons.

B. Shop Drawings: For facility propane 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 (1:50).
2. Detail mounting, supports, and valve arrangements for service meter assembly and pressure regulator assembly.

C. Delegated-Design Submittal: For propane 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.

D. Coordination Drawings: Plans and details, drawn to scale, on which propane 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 propane 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 and service meters to include in emergency, operation, and maintenance manuals.

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.

7. DELIVERY, STORAGE, AND HANDLING

A. Handling Flammable Liquids: Remove and dispose of liquids from existing propane 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.

8. PROJECT CONDITIONS

A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.

9. 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

1. PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.

1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
   a. Material Group: 1.1.
   b. End Connections: Threaded or butt welding to match pipe.
   c. Lapped Face: Not permitted underground.
   d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
   e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.
5. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.
   a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.
6. Mechanical Couplings:
   a. Manufacturers: 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) Dresser Piping Specialties; Division of Dresser, Inc.
      2) Smith-Blair, Inc.
   b. Steel flanges and tube with epoxy finish.

c. Buna-nitrile seals.
d. Steel bolts, washers, and nuts.
e. Coupling shall be capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
f. Steel body couplings installed underground on plastic pipe shall be factory equipped with anode.

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 (3.45 kPa).
6. End Fittings: Zinc-coated steel.
7. Threaded Ends: Comply with ASME B1.20.1.
8. Maximum Length: 72 inches (1830 mm).

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.

3. JOINING MATERIALS

A. 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.

B. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F (540 deg C) complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

4. MANUAL GAS SHUTOFF VALVES

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

B. General Requirements for Metallic Valves, NPS 2 (DN 50) and Smaller: Comply with ASME B16.33.
1. CWP Rating: 125 psig (862 kPa).
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 (25 mm) and smaller.
6. Service Mark: Valves 1-1/4 inches (32 mm) to NPS 2 (DN 50) shall have initials "WOG" permanently marked on valve body.

C. General Requirements for Metallic Valves, NPS 2-1/2 (DN 65) and Larger: Comply with ASME B16.38.
   1. CWP Rating: 125 psig (862 kPa).
   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.

5. PRESSURE REGULATORS

A. General Requirements:
   1. Single stage and suitable for propane gas.
   2. Steel jacket and corrosion-resistant components.
   3. End Connections: Threaded for regulators NPS 2 (DN 50) and smaller; flanged for regulators NPS 2-1/2 (DN 65) and larger.

B. Line Pressure Regulators: Comply with ANSI Z21.80.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product 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.
   3. Body and Diaphragm Case: Cast iron or die-cast aluminum.
   4. Springs: Zinc-plated steel; interchangeable.
   5. Diaphragm Plate: Zinc-plated steel.
   6. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
   7. Orifice: Aluminum; interchangeable.
   8. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
   9. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
   10. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
   11. Overpressure Protection Device: Factory mounted on pressure regulator.
   12. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
   13. Maximum Inlet Pressure: 5 psig (34.5 kPa).

C. Appliance Pressure Regulators: Comply with ANSI Z21.18.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Canadian Meter Company Inc.

b. Eaton Corporation; Controls Div.
c. Harper Wyman Co.
d. Maxitrol Company.
e. SCP, Inc.

2. Body and Diaphragm Case: Die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber.
6. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
7. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
8. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.
9. Maximum Inlet Pressure: 1 psig (6.9 kPa).

6. DIELECTRIC FITTINGS

A. Dielectric Unions:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Capitol Manufacturing Company.
b. Central Plastics Company.
c. Hart Industries International, Inc.
d. McDonald, A. Y. Mfg. Co.
e. Watts Regulator Co.; Division of Watts Water Technologies, Inc.
f. Wilkins; Zurn Plumbing Products Group.
2. Minimum Operating-Pressure Rating: 150 psig (1034 kPa).
3. Combination fitting of copper alloy and ferrous materials.
4. Insulating materials suitable for propane gas.
5. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

B. Dielectric Flanges:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Capitol Manufacturing Company.
b. Central Plastics Company.
c. Watts Regulator Co.; Division of Watts Water Technologies, Inc.
d. Wilkins; Zurn Plumbing Products Group.
2. Minimum Operating-Pressure Rating: 150 psig (1034 kPa).
3. Combination fitting of copper alloy and ferrous materials.
4. Insulating materials suitable for propane gas.
5. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

C. Dielectric-Flange Kits:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Advance Products & Systems, Inc.

b. Calpico Inc.
c. Central Plastics Company.
d. Pipeline Seal and Insulator, Inc.

2. Minimum Operating-Pressure Rating: 150 psig (1034 kPa).
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 propane gas.
6. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

7. 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.

8. 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.

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 (34.5-MPa), 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

10. 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 (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches (750 mm) deep; colored yellow.

PART 3 - EXECUTION

1. EXAMINATION

   A. Examine roughing-in for propane gas piping system to verify actual locations of piping connections before equipment installation.

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

2. PREPARATION

   A. Close equipment shutoff valves before turning off propane gas to premises or piping section.

   B. Inspect propane gas piping according to NFPA 54, the International Fuel Gas Code to determine that propane gas utilization devices are turned off in piping section affected.

   C. Comply with NFPA 54, the International Fuel Gas Code requirements for prevention of accidental ignition.

3. OUTDOOR PIPING INSTALLATION

   A. Comply with NFPA 54, the International Fuel Gas Code for installation and purging of propane gas piping.

   B. Install underground, propane gas piping buried at least 36 inches (900 mm) below finished grade. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.
      1. If propane gas piping is installed less than 36 inches (900 mm) below finished grade, install it in containment conduit.

   C. Install underground, PE, propane gas piping according to ASTM D 2774.

   D. Steel Piping with Protective Coating:
      1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
      2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
      3. Replace pipe having damaged PE coating with new pipe.

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

   F. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
      1. Install steel pipe for sleeves smaller than 6 inches (150 mm) in diameter.
      2. Install cast-iron "wall pipes" for sleeves 6 inches (150 mm) and larger in diameter.

   G. 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 (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

H. 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.

I. Install pressure gage upstream and downstream from each service regulator. Pressure gages are specified in Division 23 Section "Meters and Gages for HVAC Piping."

4. INDOOR PIPING INSTALLATION

A. Comply with NFPA 54, the International Fuel Gas Code for installation and purging of propane 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 propane 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 in Equipment Rooms: One-piece, cast-brass type.
      b. 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 (75 mm) 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. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

R. Connect branch piping from top or side of horizontal piping.

S. Install unions in pipes NPS 2 (DN 50) and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.

T. Do not use propane gas piping as grounding electrode.

U. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.

V. Install pressure gage upstream and downstream from each line regulator. Pressure gages are specified in Division 23 Section "Meters and Gages for HVAC Piping."

5. 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.

6. PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

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

C. 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. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.

E. Flanged Joints: Install gasket material, size, type, and thickness appropriate for propane gas service. Install gasket concentrically positioned.

7. 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 (DN 25) and Smaller: Maximum span, 96 inches (2438 mm); minimum rod size, 3/8 inch (10 mm).
2. NPS 1-1/4 (DN 32): Maximum span, 108 inches (2743 mm); minimum rod size, 3/8 inch (10 mm).
3. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): Maximum span, 108 inches (2743 mm); minimum rod size, 3/8 inch (10 mm).
4. NPS 2-1/2 to NPS 3-1/2 (DN 65 to DN 90): Maximum span, 10 feet (3 m); minimum rod size, 1/2 inch (13 mm).
5. NPS 4 (DN 100) and Larger: Maximum span, 10 feet (3 m); minimum rod size, 5/8 inch (15.8 mm).

8. CONNECTIONS

A. Connect to utility's gas main according to utility's procedures and requirements.

B. Install propane 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 (1800 mm) 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.

9. 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 (300 mm) below finished grade, except 6 inches (150 mm) below subgrade under pavements and slabs.

10. FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:
1. Test, inspect, and purge propane gas according to NFPA 54, the International Fuel Gas Code and authorities having jurisdiction.

C. Propane gas piping will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

11. DEMONSTRATION

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

12. OUTDOOR PIPING SCHEDULE

A. Underground propane gas piping shall be one of the following:
1. PE pipe and fittings joined by heat fusion, or mechanical couplings; service-line risers with tracer wire terminated in an accessible location.
2. Steel pipe with wrought-steel fittings and welded joints, or mechanical couplings. Coat pipe and fittings with protective coating for steel piping.

B. Aboveground propane gas piping shall be one of the following:
1. Steel pipe with malleable-iron fittings and threaded joints.
2. Steel pipe with wrought-steel fittings and welded joints.

END OF SECTION 221120

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. Section Includes:
1. In-line, sealless centrifugal pumps.
2. Horizontally mounted, in-line, separately coupled centrifugal pumps.
3. Horizontally mounted, in-line, close-coupled centrifugal pumps.
4. Vertically mounted, in-line, close-coupled centrifugal pumps.

B. Related Sections include the following:
1. Section 221123.13 "Domestic-Water Packaged Booster Pumps" for booster systems.
2. Section 332100 "Water Supply Wells" for well pumps.

1.3 DEFINITIONS

A. 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.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include materials of construction, rated capacities, certified performance curves with operating points plotted on curves, 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, without amendments, Section 7 - "Service Water Heating."

1.5 CLOSEOUT SUBMITTALS

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

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

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

1.7 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.

1.8 COORDINATION

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

PART 2 - PRODUCTS

2.1 IN-LINE, SEALLESS CENTRIFUGAL PUMPS

A. Manufacturers: Subject to compliance with requirements, [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

B. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
1. Armstrong Pumps Inc.
2. Bell & Gossett Domestic Pump; ITT Corporation.
3. Grundfos Pumps Corp.
4. TACO Incorporated.
5. WILO USA LLC - WILO Canada Inc.

C. Description: Factory-assembled and -tested, in-line, close-coupled, canned-motor, seal less, overhung-impeller centrifugal pumps.

D. Pump Construction:
1. Pump and Motor Assembly: Hermetically sealed, replaceable-cartridge type with motor and impeller on common shaft and designed for installation with pump and motor shaft horizontal.
2. Casing: Bronze, with threaded or companion-flange connections.
3. Impeller: Plastic.
4. Motor: Single speed, unless otherwise indicated.

E. Capacities and Characteristics:

1. Capacity: <Insert gpm (L/s)>.
2. Total Dynamic Head: <Insert feet (kPa)>.
3. Minimum Working Pressure: 125 psig (860 kPa).
4. Maximum Continuous Operating Temperature: 220 deg F (104 deg C).
5. Inlet and Outlet Size: <Insert NPS (DN)>.
6. Pump Speed: <Insert rpm>.
7. Pump Control: [Pressure switch] [Thermostat] [Timer].
8. Motor Horsepower: <Insert value>.
9. Electrical Characteristics:
    a. Volts: 120.
    b. Phases: Single.
    c. Hertz: 60.
    d. Full-Load Amperes: <Insert value>.
    e. Minimum Circuit Ampacity: <Insert value>.
    f. Maximum Overcurrent Protection: <Insert value> A.

2.2 HORIZONTALLY MOUNTED, IN-LINE, SEPARATELY COUPLED CENTRIFUGAL PUMPS

A. Manufacturers: Subject to compliance with requirements, [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

B. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
1. Bell & Gossett Domestic Pump; ITT Corporation.
2. Marshall Engineered Products Co.
3. TACO Incorporated.
4. Thrush Co. Inc.
5. Weinman Division; Crane Pumps & Systems.

C. Description: Factory-assembled and -tested, in-line, single-stage, separately coupled, overhung-impeller centrifugal pumps designed for installation with pump and motor shafts mounted horizontal.

D. Pump Construction:
1. Casing: Radially split with threaded companion-flange connections for pumps with NPS 2 (DN 50) pipe connections and flanged connections for pumps with NPS 2-1/2 (DN 65) pipe connections.
2. Impeller: Statically and dynamically balanced, closed, and keyed to shaft.
3. Shaft and Shaft Sleeve: Steel shaft, with copper-alloy shaft sleeve.
4. Coupling: Flexible.
5. Seal: Mechanical, with carbon-steel rotating ring, stainless-steel spring, ceramic seat, and rubber bellows and gasket.
6. Bearings: Oil-lubricated; bronze-journal or ball type.
7. Shaft Coupling: Flexible, capable of absorbing torsional vibration and shaft misalignment.

E. Motor: Single speed, with grease-lubricated ball bearings; and [resiliently] [or] [rigidly] mounted to pump casing.

F. Capacities and Characteristics:

1. Capacity: <Insert gpm (L/s)>.
2. Total Dynamic Head: <Insert feet (kPa)>.
3. Casing Material: [Bronze] [Cast iron].
4. Impeller Material: [ASTM B 584, cast bronze] [ASTM B 584, cast bronze or stainless steel] [Stainless steel].
5. Minimum Working Pressure: [125 psig (860 kPa)] [175 psig (1200 kPa)].
6. Maximum Continuous Operating Temperature: 225 deg F (107 deg C).
7. Inlet and Outlet Size: <Insert NPS (DN)>.
8. Pump Speed: <Insert rpm>.
9. Pump Control: [Pressure switch] [Thermostat] [Timer].
10. Motor Horsepower: <Insert value>.
11. Electrical Characteristics:
    a. Volts: [120] [240] <Insert value>.
    b. Phases: [Single] [Three].
    c. Hertz: 60.
    d. Full-Load Amperes: <Insert value>.
    e. Minimum Circuit Ampacity: <Insert value>.
    f. Maximum Overcurrent Protection: <Insert value> A.

2.3 HORIZONTALLY MOUNTED, IN-LINE, CLOSE-COUPLED CENTRIFUGAL PUMPS

A. Manufacturers: Subject to compliance with requirements, [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

B. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
1. Alyan Pump Co.
2. Armstrong Pumps Inc.
3. Bell & Gossett Domestic Pump; ITT Corporation.
4. Marshall Engineered Products Co.
5. PACO Pumps; Grundfos Pumps Corporation, U.S.A.
6. Pentair Pump Group; Aurora Pump.
7. TACO Incorporated.
8. Thrush Company, Inc.

C. Description: Factory-assembled and -tested, in-line, single-stage, close-coupled, overhung-impeller centrifugal pumps designed for installation with pump and motor shaft mounted horizontal.

D. Pump Construction:
1. Casing: Radially split with threaded companion-flange connections for pumps with NPS 2 (DN 50) pipe connections and flanged connections for pumps with NPS 2-1/2 (DN 65) pipe connections.
2. Impeller: Statically and dynamically balanced, closed, and keyed to shaft.
3. Shaft and Shaft Sleeve: Steel shaft with deflector, with copper-alloy shaft sleeve. Include water slinger on shaft between motor and seal.
4. Seal: Mechanical, with carbon-steel rotating ring, stainless-steel spring, ceramic seat, and rubber bellows and gasket.
5. Bearings: Oil-lubricated; bronze-journal or ball type.

6. Shaft Coupling: Flexible, capable of absorbing torsional vibration and shaft misalignment.

E. Motor: Single speed, with grease-lubricated ball bearings; and resiliently or rigidly mounted to pump casing.

F. Capacities and Characteristics:
1. Capacity: <Insert gpm (L/s)>.
2. Total Dynamic Head: <Insert feet (kPa)>.
3. Casing Material: [Bronze] [Cast iron].
4. Impeller Material: [ASTM B 584, cast bronze] [ASTM B 584, cast bronze or stainless steel] [Stainless steel].
5. Minimum Working Pressure: 175 psig (1200 kPa).
6. Maximum Continuous Operating Temperature: 225 deg F (107 deg C).
7. Inlet and Outlet Size: <Insert NPS (DN)>.
8. Pump Control: [Pressure switch] [Thermostat] [Timer].
9. Pump Speed: <Insert rpm>.
10. Motor Horsepower: <Insert value>.
11. Electrical Characteristics:
    a. Volts: [120] [240] <Insert value>.
    b. Phases: [Single] [Three].
    c. Hertz: 60.
    d. Full-Load Amperes: <Insert value>.
    e. Minimum Circuit Ampacity: <Insert value>.
    f. Maximum Overcurrent Protection: <Insert value> A.

2.4 VERTICALLY MOUNTED, IN-LINE, CLOSE-COUPLED CENTRIFUGAL PUMPS

A. Manufacturers: Subject to compliance with requirements, [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

B. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
1. Alyan Pump Co.
2. Armstrong Pumps Inc.
3. Bell & Gossett Domestic Pump; ITT Corporation.
4. Federal Pump Corp.
5. Flo Fab inc.
6. Grundfos Pumps Corp.
7. Marshall Engineered Products Co.
8. PACO Pumps; Grundfos Pumps Corporation, U.S.A.
9. Peerless Pump, Inc.
10. Pentair Pump Group; Aurora Pump.
11. TACO Incorporated.
12. Thrush Co. Inc.
13. Weinman Division; Crane Pumps & Systems.

C. Description: Factory-assembled and -tested, in-line, single-stage, close-coupled, overhung-impeller centrifugal pumps designed for installation with pump and motor shaft mounted vertical.

D. Pump Construction:
1. Casing: Radially split, cast iron, with wear rings and threaded companion-flange connections for pumps with NPS 2 (DN 50) pipe connections and flanged connections for pumps with NPS 2-1/2 (DN 65) pipe connections.[Include pump manufacturer's base attachment for mounting pump on concrete base.]
2. Impeller: Statically and dynamically balanced, closed, and keyed to shaft.
3. Shaft and Shaft Sleeve: [Stainless-steel or steel] [Stainless-steel] shaft, with copper-alloy shaft sleeve.
4. 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.
5. Bearings: Oil-lubricated; bronze-journal or ball type.
6. Shaft Coupling: Flexible or rigid type if pump is provided with coupling.

E. Motor: Single speed, with grease-lubricated ball bearings; and rigidly mounted to pump casing.

F. Capacities and Characteristics:
1. Capacity: <Insert gpm (L/s)>.
2. Total Dynamic Head: <Insert feet (kPa)>.
3. Casing Material: [Bronze] [Cast iron].
4. Impeller Material: [ASTM B 584, cast bronze] [ASTM B 584, cast bronze or stainless steel] [Stainless steel].
5. Minimum Operating Pressure: 175 psig (1200 kPa).
6. Maximum Continuous Operating Temperature: 225 deg F (107 deg C).
7. Inlet and Outlet Size: <Insert NPS (DN)>.
8. Pump Control: [Pressure switch] [Thermostat] [Timer].
9. Pump Speed: <Insert rpm>.
10. Motor Horsepower: <Insert value>.
11. Electrical Characteristics:
    a. Volts: [120] [240] <Insert value>.
    b. Phases: [Single] [Three].
    c. Hertz: 60.
    d. Full-Load Amperes: <Insert value>.
    e. Minimum Circuit Ampacity: <Insert value>.
    f. Maximum Overcurrent Protection: <Insert value> A.

2.5 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 220513 "Common Motor Requirements for Plumbing 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.

2.6 CONTROLS

A. Pressure Switches: Electric, adjustable for control of [water-supply] <Insert application> pump.
1. Type: Water-immersion pressure sensor, for installation in piping.
2. Enclosure: NEMA 250, [Type 4X] <Insert type>.

3. Operation of Pump: On or off.
4. Transformer: Provide if required.
5. Power Requirement: [24 V, ac] [120 V, ac] <Insert power>.
6. Settings: Start pump at <Insert pressure> and stop pump at <Insert pressure>.

B. Thermostats: Electric; adjustable for control of [hot-water circulation] <Insert application> pump.
1. Type: Water-immersion temperature sensor, for installation in piping.
2. Range: [50 to 125 deg F (10 to 52 deg C)] [65 to 200 deg F (18 to 93 deg C)] [100 to 240 deg F (38 to 116 deg C)] <Insert range>.
3. Enclosure: NEMA 250, [Type 4X] <Insert type>.
4. Operation of Pump: On or off.
5. Transformer: Provide if required.
6. Power Requirement: [24 V, ac] [120 V, ac] <Insert power>.
7. Settings: Start pump at [105 deg F (41 deg C)] [110 deg F (43 deg C)] [115 deg F (46 deg C)] <Insert temperature> and stop pump at [120 deg F (49 deg C)] [125 deg F (52 deg C)] <Insert temperature>.

C. Timers: Electric, for control of [hot-water circulation] <Insert application> pump.
1. Type: Programmable, [seven-day] <Insert time> clock with manual override on-off switch.
2. Enclosure: NEMA 250, [Type 1] <Insert type>, suitable for wall mounting.
3. Operation of Pump: On or off.
4. Transformer: Provide if required.
5. Power Requirement: [24-V ac] [120-V ac] <Insert power>.
6. Programmable Sequence of Operation: [Up to two on-off cycles each day for seven days] <Insert operational sequence>.

D. Time-Delay Relays: Electric, for control of hot-water circulation pump between water heater and connected hot-water storage tank.
1. Type: Adjustable time-delay relay.
2. Range: Up to five minutes.
3. Setting: Five minutes.
4. Enclosure: NEMA 250, [Type 4X] <Insert type>.
5. Operation of Pump: On or off.
6. Transformer: Provide if required.
7. Power Requirement: [24-V ac] [120-V ac] <Insert power>.
8. Programmable Sequence of Operation: Limit pump operation to periods of burner operation plus maximum five minutes after the burner stops.

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 HI 1.4.

B. Install in-line, sealless centrifugal pumps with shaft horizontal unless otherwise indicated.

C. Install horizontally mounted, in-line, [separately coupled] [and] [close-coupled] centrifugal pumps with shaft(s) horizontal.

D. Install vertically mounted, in-line, close-coupled centrifugal pumps with shaft vertical.

E. Pump Mounting: Install vertically mounted, in-line, close-coupled centrifugal pumps with cast-iron base mounted on concrete base using [elastomeric pads] [elastomeric mounts] [restrained spring isolators] <Insert device>. Comply with requirements for concrete base specified in [Section 033000 "Cast-in-Place Concrete."] [Section 033053 "Miscellaneous Cast-in-Place Concrete."]
   1. Minimum Deflection: [1/4 inch (6 mm)] [1 inch (25 mm)] <Insert dimension>.
   2. 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.
   3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   5. Install anchor bolts to elevations required for proper attachment to supported equipment.

F. Install continuous-thread hanger rods and [spring hangers] [spring hangers with vertical-limit stop] of size required to support pump weight.
   1. Comply with requirements for vibration isolation devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment." Fabricate brackets or supports as required.
   2. Comply with requirements for hangers and supports specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

G. Install pressure switches in water supply piping.

H. Install thermostats in hot-water return piping.

I. Install timers [on wall in engineer's office] <Insert location>.

J. Install time-delay relays in piping between water heaters and hot-water storage tanks.

3.3 CONNECTIONS

A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." 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.
   1. Install flexible connectors adjacent to pumps in suction and discharge piping of the following pumps:
      a. Horizontally mounted, in-line, separately coupled centrifugal pumps.
      b. Horizontally mounted, in-line, close-coupled centrifugal pumps.

c. Vertically mounted, in-line, close-coupled centrifugal pumps.
d. Comply with requirements for flexible connectors specified in Section 221116 "Domestic Water Piping."

2. Install shutoff valve and strainer on suction side of each pump, and check, shutoff, and throttling valves on discharge side of each pump. Install valves same size as connected piping. Comply with requirements for valves specified in Section 220523 "General-Duty Valves for Plumbing Piping" and comply with requirements for strainers specified in Section 221119 "Domestic Water Piping Specialties."
3. Install pressure gage[and snubber] at suction of each pump and pressure gage[and snubber] at discharge of each pump. Install at integral pressure-gage tappings where provided or install pressure-gage connectors in suction and discharge piping around pumps. Comply with requirements for pressure gages and snubbers specified in Section 220519 "Meters and Gages for Plumbing Piping."

D. Connect [pressure switches,] [thermostats,] [time-delay relays,] [and] [timers] to pumps that they control.

E. Interlock pump between water heater and hot-water storage tank with water heater burner and time-delay relay.

3.4 IDENTIFICATION

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

3.5 STARTUP SERVICE

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

3.6 ADJUSTING

A. Adjust domestic water pumps to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust initial temperature set points.

C. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

END OF SECTION 221123

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.
   3. Encasement for underground metal piping.

B. Related Sections:
   1. Section 221313 "Facility Sanitary Sewers" for sanitary sewerage piping and structures outside the building.
   2. Section 221329 "Sanitary Sewerage Pumps" for effluent and sewage pumps.
   3. Section 226600 "Chemical-Waste Systems for Laboratory and Healthcare Facilities" for chemical-waste and vent piping systems.

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
   2. Waste, Force-Main Piping: 100 psig

B. Seismic Performance: Soil, waste, and vent piping and support and installation shall withstand the effects of earthquake motions determined according to ASCE/SEI 7

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."

C. Shop Drawings: For sovent drainage system. Include plans, elevations, sections, and details.

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 and "NSF-sewer" for plastic sewer piping.

1.7 PROJECT CONDITIONS

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

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 PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.
B. Cellular-Core PVC Pipe: ASTM F 891, Schedule 40.
C. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
D. 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."
E. 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."

2.3 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:
         1) Dallas Specialty & Mfg. Co.
         2) Fernco Inc.
         3) Mission Rubber Company; a division of MCP Industries, Inc.
         4) Plastic Oddities; a division of Diverse Corporate Technologies, 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:
         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:

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] [Carbon steel] [Stainless steel] [Ductile iron] [Malleable iron].

e. Gasket Material: Natural or synthetic rubber.

f. Metal Component Finish: Corrosion-resistant coating or material.

B. Dielectric Fittings:

1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

2. Dielectric Unions:

a. Manufacturers:

1) Capitol Manufacturing Company.
2) Central Plastics Company.
3) Hart Industries International, Inc.
4) Jomar International Ltd.
5) Matco-Norca, Inc.
6) McDonald, A. Y. Mfg. Co.
7) Watts Regulator Co.; a division of Watts Water Technologies, Inc.
8) Wilkins; a Zurn company.

b. Description:

1) Standard: ASSE 1079.
2) Pressure Rating: [125 psig minimum at 180 deg F] [150 psig] [250 psig].
3) End Connections: Solder-joint copper alloy and threaded ferrous.

3. Dielectric Flanges:

a. Manufacturers:

1) Capitol Manufacturing Company.
2) Central Plastics Company.
3) Matco-Norca, Inc.
4) Watts Regulator Co.; a division of Watts Water Technologies, Inc.
5) Wilkins; a Zurn company.

b. Description:

1) Standard: ASSE 1079.
2) Factory-fabricated, bolted, companion-flange assembly.
3) Pressure Rating: [125 psig minimum at 180 deg F] [150 psig] [175 psig] [300 psig].
4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

4. Dielectric-Flange Insulating Kits:

a. Manufacturers:

1) Advance Products & Systems, Inc.
2) Calpico, Inc.
3) Central Plastics Company.

4) Pipeline Seal and Insulator, Inc.

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

5. Dielectric Nipples:
a. Manufacturers
1) Elster Perfection.
2) Grinnell Mechanical Products.
3) Matco-Norca, Inc.
4) Precision Plumbing Products, Inc.
5) Victaulic Company.

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

2.4 ENCASEMENT FOR UNDERGROUND METAL PIPING
A. Standard: ASTM A 674 or AWWA C105/A 21.5.
B. Material: high-density, cross-laminated polyethylene film of 0.004-inch minimum thickness.
C. Form: tube.
D. Color: Black

PART 3 - EXECUTION

3.1 EARTH MOVING
A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "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. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
K. 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.

L. 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.

M. 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 NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
   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.

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 steel piping according to applicable plumbing code.

P. Install stainless-steel piping according to ASME A112.3.1 and applicable plumbing code.

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

R. Install aboveground ABS piping according to ASTM D 2661.

S. Install aboveground PVC piping according to ASTM D 2665.

T. Install underground [ABS] [and] [PVC] piping according to ASTM D 2321.

U. Install engineered soil and waste drainage and vent piping systems as follows:
   1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
   2. Sovent Drainage System: Comply with ASSE 1043 and sovent fitting manufacturer's written installation instructions.
   3. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.

V. Install underground, ductile-iron, force-main piping according to AWWA C600. Install buried piping inside building between wall and floor penetrations and connection to sanitary sewer piping outside building with restrained joints. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.
   1. Install encasement on piping according to ASTM A 674 or AWWA C105/A 21.5.

W. Install underground, copper, force-main tubing according to CDA's "Copper Tube Handbook."
   1. Install encasement on piping according to ASTM A 674 or AWWA C105/A 21.5.

X. Install force mains at elevations indicated.

Y. Plumbing Specialties:
   1. Install backwater valves in sanitary waster gravity-flow piping. Comply with requirements for backwater valves specified in Section 221319 "Sanitary Waste Piping Specialties."
   2. 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 Section 221319 "Sanitary Waste Piping Specialties."
   3. Install drains in sanitary drainage gravity-flow piping. Comply with requirements for drains specified in Section 221319 "Sanitary Waste Piping Specialties."

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

AA. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

BB. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

CC. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
B. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum calked joints.
C. Grooved Joints: Cut groove ends of pipe according to AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.
D. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.
E. 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: [Unshielded] [Shielded], nonpressure transition couplings.
    3. In Aboveground Force Main Piping: Fitting-type transition couplings.
    4. In Underground Force Main Piping:
        a. NPS 1-1/2 and Smaller: Fitting-type transition couplings.
        b. NPS 2 and Larger: Pressure transition couplings.
B. Dielectric Fittings:
    1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
    2. Dielectric Fittings for 2"NPS and Smaller: Use dielectric unions.
    3. Dielectric Fittings for NPS 2-1/2 to NPS 4 Use dielectric flanges

3.5 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
B. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
    1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
    2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
    3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
    4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
    5. Vertical Piping: MSS Type 8 or Type 42, clamps.
    6. Install individual, straight, horizontal piping runs:
        a. 100 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.
C. Support horizontal piping and tubing within 12 inches of each fitting, [valve,] and coupling.
D. Support vertical piping and tubing at base and at each floor.
E. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.
F. Install hangers for and PVC piping with the following maximum horizontal spacing and minimum rod diameters:
    1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
    2. NPS 3: 48 inches with 1/2-inch rod.
    3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
    4. NPS 6 and NPS 8: 48 inches with 3/4-inch rod.
    5. NPS 10 and NPS 12: 48 inches with 7/8-inch rod.

G. Install supports for vertical [ABS] [and] [PVC] piping every 48 inches.
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 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. Install horizontal backwater valves [with cleanout cover flush with floor] [in pit with pit cover flush with floor] <Insert description>.
6. Comply with requirements for cleanouts and drains specified in Section 221319 "Sanitary Waste Piping Specialties."
7. 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. Connect force-main piping to the following:
1. Sanitary Sewer: To exterior force main.
2. Sewage Pump: To sewage pump discharge.
E. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
F. Make connections according to the following unless otherwise indicated:
1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

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

3.8 FIELD QUALITY CONTROL
A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
D. Test sanitary 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.

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

3.9 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.
D. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

3.10 PIPING SCHEDULE

1. As noted on plans.

END OF SECTION 221316

SECTION 221319 - SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Backwater valves.
2. Cleanouts.
3. Floor drains.
4. Trench drains.
5. Channel drainage systems.
6. Air-admittance valves.
7. Roof flashing assemblies.
8. Through-penetration firestop assemblies.
9. Miscellaneous sanitary drainage piping specialties.
10. Flashing materials.
11. FOG disposal systems.
12. Grease interceptors.
13. Grease removal devices.
14. Oil interceptors.
15. Solids interceptors.

B. Related Requirements:
1. Section 221423 "Storm Drainage Piping Specialties" for storm drainage piping inside the building, drainage piping specialties, and drains.
2. Section 224300 "Medical Plumbing Fixtures" for plaster sink interceptors.
3. Section 334100 "Storm Utility Drainage Piping" for storm draining piping and piping specialties outside the building.

1.3 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. FOG: Fats, oils, and greases.

C. FRP: Fiberglass-reinforced plastic.

D. HDPE: High-density polyethylene plastic.

E. PE: Polyethylene plastic.

F. PP: Polypropylene plastic.

G. PVC: Polyvinyl chloride plastic.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories for the following:
1. FOG disposal systems.
2. Grease interceptors.
3. Grease removal devices.
4. Oil interceptors.

B. Shop Drawings: Show fabrication and installation details for frost-resistant vent terminals.
1. Wiring Diagrams: Power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturer Seismic Qualification Certification: Submit certification that [FOG disposal systems,] [grease interceptors,] [grease removal devices,] [oil interceptors,] accessories, and components will withstand seismic forces defined in Section 220548 "Vibration and Seismic Controls for Plumbing 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.

B. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

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

1.7 QUALITY ASSURANCE

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

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic sanitary piping specialty components.

1.8 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in [Section 033000 "Cast-in-Place Concrete."] [Section 033053 "Miscellaneous Cast-in-Place Concrete."]

B. Coordinate size and location of roof penetrations.

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. Cultures: Provide 1-gal. (3.8-L) bottles of bacteria culture recommended by manufacturer of FOG disposal systems equal to [200] <Insert number> percent of amount installed, but no fewer than [2] <Insert number> 1-gal. (3.8-L) bottles.

PART 2 - PRODUCTS

2.1 BACKWATER VALVES

A. Horizontal, Cast-Iron Backwater Valves <Insert drawing designation if any>:
   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] <Insert manufacturer's name; product name or designation> or a comparable product by one of the following:
      a. Josam Company; Josam Div.
      b. MIFAB, Inc.
      c. Smith, Jay R. Mfr. Co.; Division of Smith Industries, Inc.
      d. Tyler Pipe; Wade Div.
      e. Watts Drainage Products Inc.
      f. Zurn Plumbing Products Group; Specification Drainage Operation.
   4. Standard: ASME A112.14.1.
   5. Size: Same as connected piping.
   6. Body: Cast iron.
   7. Cover: Cast iron with [bolted] [or] [threaded] access check valve.
   8. End Connections: [Hub and spigot] [Hub and spigot or hubless] [Hubless].

9. Type Check Valve: Removable, bronze, swing check, factory assembled or field modified to hang [closed] [open for airflow unless subject to backflow condition].
10. Extension: ASTM A 74, Service class; full-size, cast-iron, soil-pipe extension to field-installed cleanout at floor; replaces backwater valve cover.

B. Drain-Outlet Backwater Valves <Insert drawing designation if any>:
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. Josam Company; Josam Div.
   b. Smith, Jay R. Mfr. Co.; Division of Smith Industries, Inc.
   c. Watts Drainage Products Inc.
   d. Zurn Plumbing Products Group; Specification Drainage Operation.
3. Size: Same as floor drain outlet.
4. Body: Cast iron or bronze made for vertical installation in bottom outlet of floor drain.
5. Check Valve: Removable ball float.
6. Inlet: Threaded.
7. Outlet: Threaded or spigot.

C. Horizontal, Plastic Backwater Valves <Insert drawing designation if any>:
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. Canplas LLC.
   b. IPS Corporation.
   c. NDS Inc.
   d. Oatey.
   e. Plastic Oddities; a division of Diverse Corporate Technologies.
   f. Sioux Chief Manufacturing Company, Inc.
   g. Zurn Plumbing Products Group; Light Commercial Operation.
3. Size: Same as connected piping.
4. Body: [ABS] [PVC].
5. Cover: Same material as body with threaded access to check valve.
6. Check Valve: Removable swing check.
7. End Connections: Socket type.

2.2 CLEANOUTS

A. Exposed Metal Cleanouts <Insert drawing designation if any>:
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] <Insert manufacturer's name; product name or designation> or a comparable product 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.
   g. Josam Company; Blucher-Josam Div.
4. Standard: [ASME A112.36.2M for cast iron] [ASME A112.3.1 for stainless steel] <Insert standard> for cleanout test tee.
5. Size: Same as connected drainage piping
6. Body Material: [Hub-and-spigot, cast-iron soil pipe T-branch] [Hubless, cast-iron soil pipe test tee] [Stainless-steel tee with side cleanout] as required to match connected piping.
7. Closure: [Countersunk] [Countersunk or raised-head] [Raised-head], [brass] [cast-iron] [plastic] plug.
8. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
9. Closure: Stainless-steel plug with seal.

B. Metal Floor Cleanouts <Insert drawing designation if any>:
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] <Insert manufacturer's name; product name or designation> or a comparable product 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.
   i. Josam Company; Josam Div.
   j. Kusel Equipment Co.
   k. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   l. <Josam Company; Blucher-Josam Div.
4. Standard: ASME A112.36.2M for [adjustable housing] [cast-iron soil pipe with cast-iron ferrule] [heavy-duty, adjustable housing] [threaded, adjustable housing] cleanout.
5. Size: Same as connected branch.
6. Type: [Adjustable housing] [Cast-iron soil pipe with cast-iron ferrule] [Heavy-duty, adjustable housing] [Threaded, adjustable housing].
7. Body or Ferrule: [Cast iron] [Stainless steel] <Insert material>.
8. Clamping Device: [Not required] [Required].
9. Outlet Connection: [Inside calk] [Spigot] [Threaded].

10. Closure: [Brass plug with straight threads and gasket] [Brass plug with tapered threads] [Cast-iron plug] [Plastic plug].
11. Adjustable Housing Material: [Cast iron] [Plastic] <Insert material> with [threads] [set-screws or other device].
12. Frame and Cover Material and Finish: [Nickel-bronze, copper alloy] [Painted cast iron] [Polished bronze] [Rough bronze] [Stainless steel] <Insert material and finish>.
13. Frame and Cover Shape: [Round] [Square] <Insert shape>.
14. Top Loading Classification: [Extra Heavy] [Heavy] [Light] [Medium] Duty.
15. Riser: ASTM A 74, [Extra-Heavy] [Service] class, cast-iron drainage pipe fitting and riser to cleanout.
16. Standard: ASME A112.3.1.
17. Size: Same as connected branch.
18. Housing: Stainless steel.
19. Closure: Stainless steel with seal.
20. Riser: Stainless-steel drainage pipe fitting to cleanout.

C. Cast-Iron Wall Cleanouts <Insert drawing designation if any>:
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] <Insert manufacturer's name; product name or designation> or a comparable product by one of the following:
    a. Josam Company; Josam Div.
    b. MIFAB, Inc.
    c. Smith, Jay R. Mfg. Co.; d of Smith Industries, Inc.
    d. Tyler Pipe; Wade Div.
    e. Watts Drainage Products Inc.
    f. Zurn Plumbing Products Group; Specification Drainage Operation.
4. Standard: ASME A112.36.2M. Include wall access.
5. Size: Same as connected drainage piping.
6. Body: [Hub-and-spigot, cast-iron soil pipe T-branch] [Hubless, cast-iron soil pipe test tee] as required to match connected piping.
7. Closure: [Countersunk] [Countersunk or raised-head] [Raised-head], [drilled-and-threaded] [brass] [cast-iron] plug.
8. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
9. Wall Access: Round, [deep, chrome-plated bronze] [flat, chrome-plated brass or stainless-steel] cover plate with screw.
10. Wall Access: [Round] [Square], [nickel-bronze, copper-alloy, or stainless-steel] <Insert material> wall-installation frame and cover.

D. Plastic Floor Cleanouts <Insert drawing designation if any>:
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. Canplas LLC.
    b. IPS Corporation.
    c. NDS Inc.

d. Plastic Oddities; a division of Diverse Corporate Technologies.
e. Sioux Chief Manufacturing Company, Inc.
f. Zurn Plumbing Products Group; Light Commercial Operation.

3. Size: Same as connected branch.
4. Body: PVC.
5. Closure Plug: PVC.
6. Riser: Drainage pipe fitting and riser to cleanout of same material as drainage piping.

2.3 FLOOR DRAINS

A. Cast-Iron Floor Drains <Insert drawing designation if any>:
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] <Insert manufacturer's name; product name or designation> or a comparable product by one of the following:
a. Commercial Enameling Co.
b. Josam Company; Josam Div.
c. MIFAB, Inc.
d. Prier Products, Inc.
e. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
f. Tyler Pipe; Wade Div.
g. Watts Drainage Products Inc.
h. Zurn Plumbing Products Group; Light Commercial Operation.
i. Zurn Plumbing Products Group; Specification Drainage Operation.
4. Standard: ASME A112.6.3[with backwater valve].
5. Pattern: [Area] [Floor] [Funnel floor] [Sanitary] <Insert pattern> drain.
6. Body Material: [Gray iron] <Insert material>.
7. Seepage Flange: [Not required] [Required].
8. Anchor Flange: [Not required] [Required].
9. Clamping Device: [Not required] [Required].
10. Outlet: [Bottom] [Side] <Insert type>.
11. Backwater Valve: [Drain-outlet type] [Integral, ASME A112.14.1, swing-check type] [Not required].
12. Coating on Interior and Exposed Exterior Surfaces: [Acid-resistant enamel] [Not required] <Insert material>.
13. Sediment Bucket: [Not required] <Insert description>.
14. Top or Strainer Material: [Bronze] [Gray iron] [Nickel bronze] [Stainless steel] <Insert material>.
15. Top of Body and Strainer Finish: [Nickel bronze] [Polished bronze] [Rough bronze] [Stainless steel] <Insert finish>.
16. Top Shape: [Round] [Square] <Insert shape>.
17. Dimensions of Top or Strainer: <Insert dimensions and describe body, sump, and grate.>
18. Top Loading Classification: [Extra Heavy-Duty] [Heavy Duty] [Light Duty] [Medium Duty] <Delete if not applicable>.
19. Funnel: [Not required] [Required] <Insert description and dimensions>.

20. Inlet Fitting: [Not required] [Gray iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection].
21. Trap Material: [Bronze] [Cast iron] [Copper] [Not required] <Insert material>.
22. Trap Pattern: [Deep-seal P-trap] [Standard P-trap] [Not required] <Insert pattern>.
23. Trap Features: [Cleanout] [Trap-seal primer valve drain connection] [Cleanout and trap-seal primer valve drain connection] [Not required] <Insert type>.

B. Stainless-Steel Floor Drains <Insert drawing designation if any>:
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] <Insert manufacturer's name; product name or designation> or a comparable product by one of the following:
    a. Josam Company; Blucher-Josam Div.
    b. Josam Company; Josam Div.
    c. Kusel Equipment Co.
    d. Scherping Systems, Inc.
    e. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
    f. Tyler Pipe; Wade Div.
    g. Watts Drainage Products Inc.
    h. Zurn Plumbing Products Group; Specification Drainage Operation.
4. Standard: [ASME A112.3.1] [ASME A112.6.3].
5. Outlet: [Bottom] [Side] <Insert type>.
6. Top or Strainer Material: [Stainless steel] <Insert material>.
7. Top Shape: [Round] [Square] <Insert shape>.
8. Dimensions of Top or Strainer: <Insert dimensions and describe body, sump, and grate.>
9. Seepage Flange: [Not required] [Required].
10. Anchor Flange: [Not required] [Required].
11. Clamping Device: [Not required] [Required].
12. Trap-Primer Connection: [Not required] [Required].
13. Trap Material: [Cast iron] [Stainless steel] [Not required] <Insert material>.
14. Trap Pattern: [Deep-seal P-trap] [Standard P-trap] [Not required] <Insert pattern>.

C. Plastic Floor Drains <Insert drawing designation if any>:
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] <Insert manufacturer's name; product name or designation> or a comparable product by one of the following:
    a. Canplas LLC.
    b. IPS Corporation.
    c. Josam Company; Josam Div.
    d. Oatey.
    e. Plastic Oddities; a division of Diverse Corporate Technologies.
    f. Sioux Chief Manufacturing Company, Inc.

g. Zurn Plumbing Products Group; Light Commercial Operation.
4. Standard: ASME A112.6.3.
5. Material: [ABS] [or] [PVC] <Insert material>.
6. Seepage Flange: [Not required] [Required].
7. Clamping Device: [Not required] [Required].
8. Outlet: [Bottom] [Side] <Insert type>.
9. Sediment Bucket: [Not required] <Insert description>.
10. Top or Strainer Material: [Bronze] [Plastic] [Stainless steel] <Insert other>.
11. Top of Body and Strainer Finish: [Nickel bronze] [Polished bronze] [Rough bronze] [Stainless steel] <Insert other>.
12. Top Shape: [Round] [Square] <Insert shape>.
13. Dimensions of Top or Strainer: <Insert dimensions and describe body, sump, and grate if required.>
14. Trap Material: [Cast iron] [Plastic drainage piping] [Not required] <Insert material>.
15. Trap Pattern: [Standard P-trap] [Not required] <Insert pattern>.

2.4 TRENCH DRAINS

A. Trench Drains <Insert drawing designation if any>:
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] <Insert manufacturer's name; product name or designation> or a comparable product 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.
4. Standard: ASME A112.6.3 for trench drains.
5. Material: Ductile or gray iron.
6. Flange: [Anchor] [Seepage] [Not required].
7. Clamping Device: [Not required] [Required].
8. Outlet: [Bottom] [End] [Side] <Insert location>.
9. Grate Material: [Ductile iron] [Ductile iron or gray iron] [Gray iron] [Stainless steel] <Insert material>.
10. Grate Finish: [Painted] [Not required] <Insert finish>.
11. Dimensions of Frame and Grate: <Insert dimensions and describe body, sump, and grate if required.>
12. Top Loading Classification: [Extra Heavy-Duty] [Heavy Duty] [Light Duty] [Medium Duty] <Delete if not applicable>.
13. Trap Material: [Cast iron] [Stainless steel] [Not required] <Insert material>.
14. Trap Pattern: [Standard P-trap] [Not required] <Insert pattern>.

2.5 CHANNEL DRAINAGE SYSTEMS

A. Stainless-Steel Channel Drainage Systems <Insert drawing designation if any>:
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] <Insert manufacturer's name; product name or designation> or a comparable product by one of the following:
   a. Josam Company; Blucher-Josam Div.
   b. MultiDrain Systems.
   c. Zurn Plumbing Products Group; Flo-Thru Operation.
4. Type: Modular system of stainless-steel channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
   a. Standard: ASME A112.3.1, for trench drains.
   b. Channel Sections: Interlocking-joint, stainless-steel with level invert.
      1) Dimensions: [5.8 inches (147 mm)] [11.7 inches (297mm)] wide. Include number of units required to form total lengths indicated.
   c. Grates: Manufacturer's designation "[heavy] [medium] duty," with slots or perforations, and of width and thickness that fit recesses in channels.
      1) Material: [Ductile iron] [Fiberglass] [Galvanized steel] [Gray iron] [Stainless steel] <Insert material>.
      2) Locking Mechanism: [Manufacturer's standard device for securing grates to channel sections] [Not required].
   d. Covers: Solid [ductile or gray iron] [stainless steel] <Insert material>, of width and thickness that fit recesses in channels, and of lengths indicated.
   e. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
   f. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.
5. Type: Modular system of stainless-steel channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
   a. Channel Sections: Interlocking-joint, stainless steel with level invert.
      1) Dimensions: [6 inches (152 mm)] [12 inches (305 mm)] wide. Include number of units required to form total lengths indicated.
   b. Grates: Manufacturer's designation "[heavy] [medium] duty," with slots or perforations, and of width and thickness that fit recesses in channels.
      1) Material: [Ductile iron] [Fiberglass] [Galvanized steel] [Gray iron] [Stainless steel] <Insert material>.
      2) Locking Mechanism: [Manufacturer's standard device for securing grates to channel sections] [Not required].
   c. Covers: Solid [ductile or gray iron] [stainless steel] <Insert material>, of width and thickness that fit recesses in channels, and of lengths indicated.
   d. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
   e. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

B. Polymer-Concrete Channel Drainage Systems <Insert drawing designation if any>:
   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] <Insert manufacturer's name; product name or designation> or a comparable product by one of the following:
      a. ABT, Inc.
      b. ACO Polymer Products, Inc.
      c. Forte Composites, Inc.
      d. Josam Company; Mea-Josam Div.
      e. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
      f. Strongwell Corporation; Lenoir City Division.
      g. ABT, Inc.
      h. ACO Polymer Products, Inc.
      i. Forte Composites, Inc.
      j. Josam Company; Mea-Josam Div.
      k. ABT, Inc.
      l. ACO Polymer Products, Inc.
      m. Josam Company; Mea-Josam Div.
      n. Strongwell Corporation; Lenoir City Division.
   4. Type: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
      a. Channel Sections: Narrow, interlocking-joint, sloped-invert, polymer-concrete modular units with end caps. Include rounded bottom, with built-in invert slope of 0.6 percent and with outlets in number, sizes, and locations indicated. Include extension sections necessary for required depth.
         1) Dimensions: 4-inch (102-mm) inside width. Include number of units required to form total lengths indicated.
         2) Frame: [Gray-iron or galvanized steel for grates] [Not required].
      b. Grates: Manufacturer's designation "[heavy] [medium] duty," with slots or perforations, and of width and thickness that fit recesses in channel sections.
         1) Material: [Ductile iron] [Fiberglass] [Galvanized steel] [Gray iron] [Stainless steel] <Insert material>.
         2) Locking Mechanism: [Manufacturer's standard device for securing grates to channel sections] [Not required].
      c. Covers: Solid [ductile or gray iron] <Insert material>, of width and thickness that fit recesses in channel sections, and of lengths indicated.
      d. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
      e. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.
      f. Channel Sections: Narrow, interlocking-joint, precast, polymer-concrete modular units with end caps. Include rounded bottom, with level invert and with NPS 4 (DN 100) outlets in number and locations indicated.
         1) Dimensions: [5-inch (127-mm)] <Insert dimension> inside width and [9-3/4 inches (248 mm)] <Insert dimension> deep. Include number of units required to form total lengths indicated.
         2) Frame: [Gray-iron or galvanized steel for grates] [Not required].

g. Grates: Manufacturer's designation "[heavy] [medium] duty," with slots or perforations, and of width and thickness that fit recesses in channel sections.
   1) Material: [Ductile iron] [Fiberglass] [Galvanized steel] [Gray iron] [Stainless steel] <Insert material>.
   2) Locking Mechanism: [Manufacturer's standard device for securing grates to channel sections] [Not required].
h. Covers: Solid [ductile or gray iron] <Insert material>, of width and thickness that fit recesses in channel sections, and of lengths indicated.
i. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
j. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.
k. Channel Sections: Wide, interlocking-joint, precast, polymer-concrete modular units with end caps. Include flat or rounded bottom, with level invert and with outlets in number, sizes, and locations indicated.
   1) Dimensions: [8-inch (203-mm)] <Insert dimension> inside width and [13-3/4 inches (350 mm)] <Insert dimension> deep. Include number of units required to form total lengths indicated.
   2) Frame: [Gray-iron or galvanized steel for grates] [Not required].
l. Grates: Manufacturer's designation "[heavy] [medium] duty," with slots or perforations, and of width and thickness that fit recesses in channel sections.
   1) Material: [Ductile iron] [Fiberglass] [Galvanized steel] [Gray iron] [Stainless steel] <Insert material>.
   2) Locking Mechanism: [Manufacturer's standard device for securing grates to channel sections] [Not required].
m. Covers: Solid [ductile or gray iron] <Insert material>, of width and thickness that fit recesses in channel sections, and of lengths indicated.
n. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
o. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

C. Polymer-Concrete Sediment Interceptor <Insert drawing designation if any>:
   1. Description: [27-inch- (686-mm-)] <Insert dimension> square, precast, polymer-concrete body, with outlets in number and sizes indicated. Include 24-inch- (610-mm-) square, gray-iron slotted grate.
   2. Frame: [Gray-iron or galvanized steel for grate] [Not required].

D. FRP Channel Drainage Systems <Insert drawing designation if any>:
   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] <Insert manufacturer's name; product name or designation> or a comparable product by one of the following:
      a. ACO Polymer Products, Inc.
      b. Aquaduct, Inc.; an ACO Polymer Products, Inc. Company.
      c. Josam Company; Mea-Josam Div.

d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
e. Zurn Plumbing Products Group; Flo-Thru Operation.

4. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
   a. Channel Sections: Interlocking-joint, sloped-invert, FRP modular units, with end caps. Include flat, rounded, or inclined inside bottom, with outlets in number, sizes, and locations indicated.
      1) Dimensions: [4 inches (102 mm)] [4 or 6 inches (102 or 152 mm)] [6 inches (152 mm)] [6 or 8 inches (152 or 203 mm)] [8 inches (203 mm)] wide. Include number of units required to form total lengths indicated.
      2) Frame: [Galvanized steel] [Stainless steel] [Manufacturer's standard metal] <Insert material> for grates.
   b. Grates: With slots or perforations and widths and thickness that fit recesses in channel sections.
      1) Material: [Fiberglass] [Galvanized steel] [Gray iron] [Stainless steel] <Insert material>.
      2) Locking Mechanism: [Manufacturer's standard device for securing grates to channel sections] [Not required].
   c. Covers: Solid [ductile or gray iron] <Insert material>, of width and thickness that fit recesses in channel sections, and of lengths indicated.
   d. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
   e. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

E. Plastic Channel Drainage Systems <Insert drawing designation if any>:
   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] <Insert manufacturer's name; product name or designation> or a comparable product by one of the following:
      a. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
      b. Tuf-Tite Corporation.
      c. Zurn Plumbing Products Group; Flo-Thru Operation.
      d. Infinity Plastics, Inc.
      e. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
      f. MultiDrain Systems.
      g. NDS Inc.
      h. Infinity Plastics, Inc.
      i. MultiDrain Systems.
      j. NDS Inc.
      k. Smith, Jay R. Mfg Co.; Division of Smith Industries, Inc.
      l. Tuf-Tite Corporation.
      m. Zurn Plumbing Products Group; Flo-Thru Operation.

   4. Type: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.

a. Channel Sections: Interlocking-joint, [HDPE or PE] [PP] [or] [PVC] modular units, with end caps. Include flat, rounded, or inclined bottom, with level invert and with outlets in number, sizes, and locations indicated.
   1) Dimensions: 4 inches (102 mm) wide. Include number of units required to form total lengths indicated.
b. Grates: With slots or perforations and widths and thickness that fit recesses in channel sections.
   1) Material: [Fiberglass] [Galvanized steel] [Gray iron] [Stainless steel] <Insert material>.
   2) Color: <Insert color or delete subparagraph.>
c. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
d. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

2.6 AIR-ADMITTANCE VALVES

A. Fixture Air-Admittance Valves <Insert drawing designation if any>:
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. Ayrlett, LLC.
   b. Durgo, Inc.
   c. Oatey.
   d. ProSet Systems Inc.
   e. RectorSeal.
   f. Studor, Inc.
3. Standard: ASSE 1051, Type A for single fixture or Type B for branch piping.
4. Housing: Plastic.
5. Operation: Mechanical sealing diaphragm.
6. Size: Same as connected fixture or branch vent piping.

B. Stack Air-Admittance Valves <Insert drawing designation if any>:
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. Durgo, Inc.
   b. Oatey.
   c. Studor, Inc.
3. Standard: ASSE 1050 for vent stacks.
4. Housing: Plastic.
5. Operation: Mechanical sealing diaphragm.
6. Size: Same as connected stack vent or vent stack.

C. Wall Box <Insert drawing designation if any>:

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. Durgo, Inc.
   b. Oatey.
   c. RectorSeal.
   d. Studor, Inc.
3. Description: White plastic housing with white plastic grille, made for recessed installation. Include bottom pipe connection and space to contain one air-admittance valve.
4. Size: About 9 inches wide by 8 inches high by 4 inches deep (230 mm wide by 200 mm high by 100 mm deep).

2.7 ROOF FLASHING ASSEMBLIES

A. Roof Flashing Assemblies <Insert drawing designation if any>:
   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] <Insert manufacturer's name; product name or designation> or a comparable product by one of the following:
      a. Acorn Engineering Company; Elmdor/Stoneman Div.
      b. Thaler Metal Industries Ltd.

B. Description: Manufactured assembly made of [4.0-lb/sq. ft. (20-kg/sq. m), 0.0625-inch- (1.6-mm-)] [6.0-lb/sq. ft. (30-kg/sq. m), 0.0938-inch- (2.4-mm-)] thick, lead flashing collar and skirt extending at least [6 inches (150 mm)] [8 inches (200 mm)] [10 inches (250 mm)] from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.
   1. Open-Top Vent Cap: Without cap.
   2. Low-Silhouette Vent Cap: With vandal-proof vent cap.
   3. Extended Vent Cap: With field-installed, vandal-proof vent cap.

2.8 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Firestop Assemblies <Insert drawing designation if any>:
   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.

2.9 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Open Drains <Insert drawing designation if any>:
1. Description: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564, rubber gaskets.
2. Size: Same as connected waste piping[with increaser fitting of size indicated].

B. Deep-Seal Traps <Insert drawing designation if any>:
1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
2. Size: Same as connected waste piping.
a. NPS 2 (DN 50): 4-inch- (100-mm-) minimum water seal.
b. NPS 2-1/2 (DN 65) and Larger: 5-inch- (125-mm-) minimum water seal.

C. Floor-Drain, Trap-Seal Primer Fittings <Insert drawing designation if any>:
1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
2. Size: Same as floor drain outlet with NPS 1/2 (DN 15) side inlet.

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

E. Sleeve Flashing Device <Insert drawing designation if any>:
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 (25 mm)] [2 inches (51 mm)] <Insert dimension> above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
2. Size: As required for close fit to riser or stack piping.

F. Stack Flashing Fittings <Insert drawing designation if any>:
1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
2. Size: Same as connected stack vent or vent stack.

G. Vent Caps <Insert drawing designation if any>:
1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.
2. Size: Same as connected stack vent or vent stack.

H. Frost-Resistant Vent Terminals <Insert drawing designation if any>:
1. Description: Manufactured or shop-fabricated assembly constructed of copper, lead-coated copper, or galvanized steel.
2. Design: To provide 1-inch (25-mm) enclosed air space between outside of pipe and inside of flashing collar extension, with counterflashing.

I. Expansion Joints <Insert drawing designation if any>:
1. Standard: ASME A112.21.2M.
2. Body: Cast iron with bronze sleeve, packing, and gland.
3. End Connections: Matching connected piping.
4. Size: Same as connected soil, waste, or vent piping.

2.10 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. (20-kg/sq. m), 0.0625-inch (1.6-mm) thickness.
2. Vent Pipe Flashing: 3.0-lb/sq. ft. (15-kg/sq. m), 0.0469-inch (1.2-mm) thickness.
3. Burning: 6-lb/sq. ft. (30-kg/sq. m), 0.0938-inch (2.4-mm) thickness.

B. Copper Sheet: ASTM B 152/B 152M, of the following minimum weights and thicknesses, unless otherwise indicated:
1. General Applications: 12 oz./sq. ft. (3.7 kg/sq. m or 0.41-mm thickness).
2. Vent Pipe Flashing: 8 oz./sq. ft. (2.5 kg/sq. m or 0.27-mm thickness).

C. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch (1.01-mm) minimum thickness, unless otherwise indicated. Include G90 (Z275) hot-dip galvanized, mill-phosphatized finish for painting if indicated.

D. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil (1.01-mm) minimum thickness.

E. Fasteners: Metal compatible with material and substrate being fastened.

F. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

G. Solder: ASTM B 32, lead-free alloy.

H. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

2.11 FOG DISPOSAL SYSTEMS

A. FOG Disposal Systems <Insert drawing designation if any>:
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] <Insert manufacturer's name; product name or designation> or a comparable product by one of the following:
   a. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
4. Standard: IAPMO PS 118, for removing solids from and breaking down and digesting suspended fats, oils, and greases from food[-preparation] [or] [-processing] wastewater.
5. Flow-Control Fitting: Matching unit size.
6. Strainer Unit: Stainless-steel housing with aluminum cover and removable-basket-type, stainless-steel, wire-mesh strainer.[Include pressure plug instead of cover.] [Include extra basket.] [Include stainless-steel extension.]
7. Media Chamber: Stainless-steel housing and aluminum cover, with internal baffles, piping, plastic coalescing surfaces, and clarifier section with test ports.[Include stainless-steel extension.]
8. Shelf: Stainless steel, 19.5 inches wide by 13 inches high by 8.75 inches deep (495 mm wide by 330 mm high by 222 mm deep), for metering pump, control devices, and culture bottle.
9. Culture Metering Pump, Timer, Control, and Tubing: Proprietary.
10. Culture: Include 1-gal. (3.8-L) bottle, as recommended by unit manufacturer.
11. Strainer and Media-Chamber, Unit Size: [20 gpm (1.26 L/s)] [35 gpm (2.21 L/s)].
12. Inlet and Outlet: NPS 2 (DN 50).
13. Strainer and Media-Chamber, Unit Size: [50 gpm (3.15 L/s)] [75 gpm (4.73 L/s)].
14. Inlet and Outlet: NPS 3 (DN 80).
15. Piping: Waste and vent piping is specified in Section 221316 "Sanitary Waste and Vent Piping."
16. Power Requirement: [120-V ac] <Insert power>.
17. Full-Load Amperes: <Insert value> A.
18. Minimum Circuit Ampacity: <Insert value> A.
19. Maximum Overcurrent Protection: <Insert value> A.

2.12 GREASE INTERCEPTORS

A. Grease Interceptors <Insert drawing designation if any>:

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] <Insert manufacturer's name; product name or designation> or a comparable product by one of the following:
   a. Applied Chemical Technology, Incorporated.
   b. Josam Company; Josam Div.
   c. MIFAB, Inc.
   d. Rockford Sanitary Systems, Inc.
   e. Schier Products Company.
   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; Light Commercial Operation.

j. Zurn Plumbing Products Group; Specification Drainage Operation.
k. Ashland Trap Distribution Co.
l. Bio-Microbics, Inc.
m. Canplas LLC.
n. Schier Products Company.
o. Zurn Plumbing Products Group; Light Commercial Operation.

4. Standard: ASME A112.14.3[and PDI-G101], for intercepting and retaining fats, oils, and greases from food[-preparation] [or] [-processing] wastewater.
5. Plumbing and Drainage Institute Seal: [Not required] [Required].
6. Body Material: [Cast iron] [Cast iron or steel] [Plastic] <Insert material>.
7. Interior Lining: [Corrosion-resistant enamel] [Not required] <Insert lining>.
8. Exterior Coating: [Corrosion-resistant enamel] [Not required] <Insert coating>.
9. Body Dimensions: <Insert dimensions.>
10. Body Extension: [Not required] [Required].
11. Flow Rate: <Insert interceptor design rate.>
12. Grease Retention Capacity: <Insert capacity.>
13. Inlet and Outlet Size: <Insert size.>
14. End Connections: [Flanged] [Hub] [Threaded].
15. Cleanout: Integral[or field installed on outlet].
16. Mounting: [Above floor] [Recessed in acid-resistant, coated steel frame and cradle] [Recessed, flush with floor] <Insert mounting>.
17. Flow-Control Fitting: [Not required] [Required].
18. Operation: [Automatic recovery] [Manual cleaning] [Semiautomatic, manual drawoff] <Insert operation>.

2.13 GREASE REMOVAL DEVICES

A. Grease Removal Devices <Insert drawing designation if any>:
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] <Insert manufacturer's name; product name or designation> or a comparable product by one of the following:
a. Applied Chemical Technology, Incorporated.
b. G K & L, Inc.
c. International Grease Recovery Device.
d. Josam Company; Blucher-Josam Div.
e. Lowe Engineering; a division of Highland Tank & Manufacturing Co., Inc.
f. Thermaco, Inc.
4. Standard: ASME A112.14.4[and with PDI-G101 for flow tests], for automatic intercepting and removal of fats, oils, and greases from food[-preparation] [or] [-processing] <Insert application> wastewater.
5. Body Material: [Stainless steel] [Steel] <Insert material>.
6. Interior Separation Device: [Baffles] [Screens] <Insert device>.
7. Heater: [Not required] [Required].
8. Interior Lining: [Not required] <Insert description if required>.
9. Exterior Coating: [Not required] <Insert description if required>.
10. Unit Dimensions: <Insert dimensions.>

11. Flow Rate: <Insert recovery unit design rate.>
12. Basket Material: [Stainless steel] <Insert material>.
13. Inlet and Outlet Size: <Insert size.>
14. End Connections: [Flanged] [Hub] [Threaded].
15. Cleanout: Integral[or field installed on outlet].
16. Mounting: [Above floor] <Insert mounting>.
17. Flow-Control Fitting: [Not required] [Required].
18. Operation: [Automatic recovery] <Insert operation>.
19. Power Requirement: [120-V ac] <Insert power>.
20. Full-Load Amperes: <Insert value> A.
21. Minimum Circuit Ampacity: <Insert value> A.
22. Maximum Overcurrent Protection: <Insert value> A.
23. Waste Grease Receptacle: [Furnished by Owner] <Insert description>.

2.14 OIL INTERCEPTORS

A. Oil Interceptors <Insert drawing designation if any>:

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] <Insert manufacturer's name; product name or designation> or a comparable product by one of the following:
    a. Applied Chemical Technology, Incorporated.
    b. Josam Company; Josam Div.
    c. MIFAB, Inc.
    d. Rockford Sanitary Systems, Inc.
    e. Schier Products Company.
    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.
    j. Ashland Trap Distribution Co.
    k. Schier Products Company.
    l. Town & Country Plastics, Inc.
4. Type: Factory-fabricated interceptor for separating and removing [light oil] <Insert type of oil> from wastewater.
5. Body Material: [Cast iron or steel] [Plastic] <Insert material>.
6. Interior Lining: [Corrosion-resistant enamel] [Not required] <Insert lining>.
7. Exterior Coating: [Corrosion-resistant enamel] [Not required] <Insert coating>.
8. Body Dimensions: <Insert dimensions.>
9. Flow Rate: <Insert interceptor design rate.>
10. Inlet and Outlet Size: <Insert size.>
11. End Connections: [Flanged] [Hub] [Threaded].
12. Cleanout: Integral[or field installed on outlet].
13. Mounting: [Above floor] [Recessed in acid-resistant, coated steel frame and cradle] [Recessed, flush with floor] <Insert mounting>.
14. Flow-Control Fitting: [Not required] [Required].

15. Descriptive Type or Function: <Describe type or function or delete subparagraph.>
16. Oil Storage Tank: [Coordinate with Section 231113 "Facility Fuel-Oil Piping."] <Insert tank description.>

2.15 SOLIDS INTERCEPTORS

A. Solids Interceptors <Insert drawing designation if any>:

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] <Insert manufacturer's name; product name or designation> or a comparable product by one of the following:
   a. Josam Company; Josam Div.
   b. MIFAB, Inc.
   c. Rockford Sanitary Systems, Inc.
   d. Schier Products Company.
   e. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   f. Tyler Pipe; Wade Div.
   g. Watts Drainage Products Inc.
   h. Zurn Plumbing Products Group; Specification Drainage Operation.
   i. Ashland Trap Distribution Co.
   j. Schier Products Company.
   k. Town & Country Plastics, Inc.
4. Type: Factory-fabricated interceptor made for removing and retaining [lint] [sediment] <Insert solid> from wastewater.
5. Body Material: [Cast iron or steel] [Stainless steel] [Plastic] <Insert material>.
6. Interior Separation Device: [Baffles] [Screens] <Insert device>.
7. Interior Lining: [Corrosion-resistant enamel] [Not required] <Insert lining>.
8. Exterior Coating: [Corrosion-resistant enamel] [Not required] <Insert coating>.
9. Body Dimensions: <Insert dimensions.>
10. Flow Rate: [Not required] <Insert description if required>.
11. Inlet and Outlet Size: <Insert size.>
12. End Connections: [Threaded] <Insert connections>.
13. Mounting: [Above floor] [Inline] <Insert mounting>.

2.16 MOTORS

A. General requirements for motors are specified in Section 220513 "Common Motor Requirements for Plumbing 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.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Equipment Mounting: Install [FOG disposal systems] [grease interceptors] [grease removal devices] [and] [solids interceptors] on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases specified in [Section 033000 "Cast-in-Place Concrete."] [Section 033053 "Miscellaneous Cast-in-Place Concrete."]
   1. Coordinate sizes and locations of concrete bases with actual equipment provided.
   2. Construct bases to withstand, without damage to equipment, seismic force required by code.
   3. Construct concrete bases [4 inches (100 mm)] [6 inches (150 mm)] [8 inches (200 mm)] <Insert dimension> high and extend base not less than 6 inches (150 mm) in all directions beyond the maximum dimensions of [FOG disposal systems] [grease interceptors] [grease removal devices] [and] [solids interceptors], unless otherwise indicated or unless required for seismic anchor support.
   4. Minimum Compressive Strength: [5000 psi (34.5 MPa)] [4500 psi (31 MPa)] [4000 psi (27.6 MPa)] [3500 psi (24.1 MPa)] [3000 psi (20.7 MPa)] <Insert strength> at 28 days.
   5. 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.
   6. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base, and anchor into structural concrete floor.
   7. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   8. Install anchor bolts to elevations required for proper attachment to supported equipment.

B. 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.

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

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

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

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

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

H. Assemble and install ASME A112.3.1, stainless-steel channel drainage systems according to ASME A112.3.1. Install on support devices so that top will be flush with surface.

I. Assemble non-ASME A112.3.1, stainless-steel channel drainage system components according to manufacturer's written instructions. Install on support devices so that top will be flush with adjacent surface.

J. Assemble FRP channel drainage system components according to manufacturer's written instructions. Install on support devices so that top will be flush with adjacent surface.

K. Assemble plastic channel drainage system components according to manufacturer's written instructions. Install on support devices so that top will be flush with adjacent surface.

L. Install fixture air-admittance valves on fixture drain piping.

M. Install stack air-admittance valves at top of stack vent and vent stack piping.

N. Install air-admittance-valve wall boxes recessed in wall.

O. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.

P. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.

Q. Install through-penetration firestop assemblies in plastic [conductors] [and] [stacks] at floor penetrations.

R. Assemble open drain fittings and install with top of hub [1 inch (25 mm)] [2 inches (51 mm)] <Insert dimension> above floor.

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

T. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
   1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
   2. Size: Same as floor drain inlet.

U. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

V. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

W. Install vent caps on each vent pipe passing through roof.

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

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

Z. Install frost-proof vent caps on each vent pipe passing through roof. Maintain 1-inch (25-mm) clearance between vent pipe and roof substrate.

AA. Assemble components of FOG disposal systems and install on floor. Install trap, vent, fresh-air inlet, and flow-control fitting according to authorities having jurisdiction. Install shelf fastened to reinforcement in wall construction and adjacent to unit, unless otherwise indicated. Install culture bottle, culture metering pump, timer, and control on shelf. Install tubing between culture bottle, metering pump, and chamber.

BB. Install grease interceptors, including trapping, venting, and flow-control fitting, according to authorities having jurisdiction and with clear space for servicing.
   1. Above-Floor Installation: Set unit with bottom resting on floor, unless otherwise indicated.
   2. Flush with Floor Installation: Set unit and extension, if required, with cover flush with finished floor.
   3. Recessed Floor Installation: Set unit in receiver housing having bottom or cradle supports, with receiver housing cover flush with finished floor.
   4. Install cleanout immediately downstream from interceptors not having integral cleanout on outlet.

CC. Install grease removal devices on floor. Install trap, vent, and flow-control fitting according to authorities having jurisdiction. Install control panel adjacent to unit, unless otherwise indicated.

DD. Install oil interceptors, including trapping, venting, and flow-control fitting, according to authorities having jurisdiction and with clear space for servicing. Coordinate oil-interceptor storage tank and gravity drain with Section 231113 "Facility Fuel-Oil Piping."

EE. Install solids interceptors with cleanout immediately downstream from interceptors that do not have integral cleanout on outlet. Install trap on interceptors that do not have integral trap and are connected to sanitary drainage and vent systems.

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

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

3.2 CONNECTIONS

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

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

C. FOG Disposal Systems: Connect inlet and outlet to unit, connect flow-control fitting and fresh-air inlet piping to unit inlet piping, and connect vent piping between trap and media chamber. Connect electrical power.

D. Grease Interceptors: Connect inlet and outlet to unit, and connect flow-control fitting and vent to unit inlet piping. Install valve on outlet of automatic drawoff-type unit.

E. Grease Removal Devices: Connect controls, electrical power, factory-furnished accessories, and inlet, outlet, and vent piping to unit.

F. Oil Interceptors: Connect inlet, outlet, vent, and gravity drawoff piping to unit; flow-control fitting and vent to unit inlet piping; and gravity drawoff and suction piping to oil storage tank.

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."

3.3 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. (30-kg/sq. m), 0.0938-inch (2.4-mm) thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft. (20-kg/sq. m), 0.0625-inch (1.6-mm) thickness or thinner.
   2. Copper Sheets: Solder joints of copper sheets.

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 (250 mm), and skirt or flange extending at least 8 inches (200 mm) around pipe.
   2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches (200 mm) around sleeve.
   3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches (200 mm) 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 Section 076200 "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 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
1. FOG disposal systems.
2. Grease interceptors.
3. Grease removal devices.
4. Oil interceptors.
5. Solids interceptors.

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 Section 220553 "Identification for Plumbing Piping and Equipment."

3.5 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 [FOG disposal systems] [and] [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.

3.6 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.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain [FOG disposal systems] [and] [grease removal devices]. Refer to Section 017900 "Demonstration and Training." 01820

END OF SECTION 221319

SECTION 223300 - ELECTRIC, DOMESTIC-WATER HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Commercial, electric, storage, domestic-water heaters.
   2. Domestic-water heater accessories.

1.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Commercial domestic-water heaters shall withstand the effects of earthquake motions determined according to [ASCE/SEI 7] <Insert requirement>.
   1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[and the unit will be fully operational after the seismic event]."

1.4 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.

1.5 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For commercial 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 [commercial] [residential] [and] [tankless], electric, 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.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For electric, domestic-water heaters to include in emergency, operation, and maintenance manuals.

1.7 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: Applicable requirements in ASHRAE/IESNA 90.1.

C. ASME Compliance: Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61, "Drinking Water System Components - Health Effects."

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

1.9 WARRANTY
A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of electric, domestic-water heaters that fail in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to, the following:
a. Structural failures including storage tank and supports.
b. Faulty operation of controls.
c. Deterioration of metals, metal finishes, and other materials beyond normal use.
2. Warranty Periods: From date of Substantial Completion.
a. Commercial, Electric, Domestic-Water Booster Heaters:
1) Controls and Other Components: [Three] [Five] <Insert number> years.
b. Commercial, Electric, Storage, Domestic-Water Heaters:
1) Storage Tank: [Three] [Five] <Insert number> years.
2) Controls and Other Components: [Three] [Five] <Insert number> years.
c. Commercial, Light-Duty, Storage, Electric, Domestic-Water Heaters:
1) Storage Tank: [Three] [Five] <Insert number> years.
2) Controls and Other Components: [Two] [Three] <Insert number> years.
d. Residential, Electric, Storage, Domestic-Water Heaters:
1) Storage Tank: [Five] [Six] [10] <Insert number> years.
2) Controls and Other Components: [Two] [Three] <Insert number> years.
e. Electric, Tankless, Domestic-Water Heaters: [One] [Two] [Five] <Insert number> year(s).
f. Compression Tanks: [Five] <Insert number> years.

PART 2 - PRODUCTS

2.1 COMMERCIAL, ELECTRIC, domestic-WATER HEATERS
A. Commercial, Electric, Storage, Domestic-Water Heaters:
1. Manufacturers:
a. Bradford White Corporation.
b. Rheem Manufacturing Company.
c. Smith, A. O. Water Products Co.; a division of A. O. Smith Corporation.
d. State Industries.
2. Standard: UL 1453.
3. Storage-Tank Construction: ASME-code, steel vertical arrangement.
a. Tappings: Factory fabricated of materials compatible with tank and piping connections. Attach tappings to tank before testing.
1) NPS 2 (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. Pressure Rating: 150 psig (1035 kPa.
c. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.
4. Factory-Installed Storage-Tank Appurtenances:
a. Anode Rod: Replaceable magnesium.
b. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
c. Insulation: Comply with ASHRAE/IESNA 90.1.

d. Jacket: Steel with enameled finish.
e. Heating Elements: Electric, screw-in or bolt-on immersion type arranged in multiples of three.
f. Temperature Control: Adjustable thermostat.
g. Safety Controls: High-temperature-limit and low-water cutoff devices or systems.
h. Relief Valves: ASME rated and stamped for combination temperature-and-pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.

5. Special Requirements: NSF 5 construction.

2.2 DOMESTIC-WATER HEATER ACCESSORIES

A. Domestic-Water Compression Tanks:
1. Manufacturers:
a. AMTROL Inc.
b. Flexcon Industries.
c. Honeywell International Inc.
d. Smith, A. O. Water Products Co.; a division of A. O. Smith Corporation.
e. State Industries.
f. 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:
a. Working-Pressure Rating150 psig (1035 kPa).
b. 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] [memory-stop] balancing valves to provide balanced flow through each domestic-water heater.
1. Comply with requirements for ball-, butterfly-, or gate-type shutoff valves specified in Section 220523 "General-Duty Valves for Plumbing Piping."
2. Comply with requirements for balancing valves specified in Section 221119 "Domestic Water Piping Specialties."

F. Pressure-Reducing Valves: ASSE 1003 for water. Set at 25-psig- (172.5-kPa-) maximum outlet pressure unless otherwise indicated.

G. Combination Temperature-and-Pressure Relief Valves: ASME rated and stamped. Include relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.

H. Pressure Relief Valves: ASME rated and stamped. Include pressure setting less than domestic-water heater working-pressure rating.

I. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4.

J. Shock Absorbers: ASSE 1010 or PDI-WH 201, Size A water hammer arrester.
K. Domestic-Water Heater Stands: Manufacturer's factory-fabricated steel stand for floor mounting, capable of supporting domestic-water heater and water. Include dimension that will support bottom of domestic-water heater a minimum of 18 inches (457 mm) above the floor.
L. 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 domestic-water heaters specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.
B. Hydrostatically test[commercial] domestic-water heaters to minimum of one and one-half times pressure rating before shipment.
C. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 014000 "Quality Requirements" for retesting and reinspecting requirements and Section 017300 "Execution" for requirements for correcting the Work.
D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 DOMESTIC-WATER HEATER INSTALLATION
A. Commercial, Electric, Domestic-Water Heater Mounting: Install commercial, electric, domestic-water heaters on concrete base. Comply with requirements for concrete bases specified in [Section 033000 "Cast-in-Place Concrete."] [Section 033053 "Miscellaneous Cast-in-Place Concrete."]
1. Exception: Omit concrete bases for commercial, electric, domestic-water heaters if installation on stand, bracket, suspended platform, or directly on floor is indicated.
2. Maintain manufacturer's recommended clearances.
3. Arrange units so controls and devices that require servicing are accessible.
4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (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 electric, 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 Section 220523 "General-Duty Valves for Plumbing Piping."
C. Install commercial, electric, domestic-water heaters with seismic-restraint devices. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
D. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend 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.
E. Install [combination temperature-and-]pressure relief valves in water piping for electric, 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.

F. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for electric, domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Section 221119 "Domestic Water Piping Specialties."
G. Install thermometers on outlet piping of electric, domestic-water heaters. Comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Plumbing Piping."
H. Install thermometers on inlet and outlet piping of residential, solar, electric, domestic-water heaters. Comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Plumbing Piping."
I. Assemble and install inlet and outlet piping manifold kits for multiple electric, domestic-water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each electric, domestic-water heater. Include shutoff valve and thermometer in each domestic-water heater inlet and outlet, and throttling valve in each electric, domestic-water heater outlet. Comply with requirements for valves specified in Section 220523 "General-Duty Valves for Plumbing Piping," and comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Plumbing Piping."
J. Install pressure-reducing valve with integral bypass relief valve in electric, domestic-water booster-heater inlet piping and water hammer arrester in booster-heater outlet piping. Set pressure-reducing valve for outlet pressure of [25 psig (172 kPa)] <Insert value>. Comply with requirements for pressure-reducing valves and water hammer arresters specified in Section 221119 "Domestic Water Piping Specialties."
K. Install piping-type heat traps on inlet and outlet piping of electric, domestic-water heater storage tanks without integral or fitting-type heat traps.
L. Fill electric, domestic-water heaters with water.
M. Charge domestic-water compression tanks with air.

3.2 CONNECTIONS

A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
B. Where installing piping adjacent to electric, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.3 IDENTIFICATION

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

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.
   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. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 014000 "Quality Requirements" for retesting and reinspecting requirements and Section 017300 "Execution" for requirements for correcting the Work.
C. Prepare test and inspection reports.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train] [Train] Owner's maintenance personnel to adjust, operate, and maintain [commercial] [and] [tankless], electric, domestic-water heaters.

END OF SECTION 223300

SECTION 224100 - 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 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

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

B. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For plumbing fixtures and faucets to include in emergency, operation, and operation and maintenance manuals.
   1. In addition to items specified in Section 017000 "Execution and Closeout Requirements," include the following:

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Faucet 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-Tank Repair Kits: Equal to 5 percent of amount of each type installed, but no fewer than two of each type.
   4. Toilet Seats: Equal to 5 percent of amount of each type installed.

PART 2 - PRODUCTS (SEE DRAWINGS FOR FIXTURES AND TRIM SPECIFICATIONS)

2.1 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 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 walls, floors, cabinets, and counters for suitable conditions where fixtures will be installed.

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

3.2 INSTALLATION

A. Install plumbing fixtures level and plumb according to roughing-in drawings.

B. Install per ADA/TAS requirements where applicable. Coordinate flush valves with grab bar locations.

C. Install floor-mounted water closets on closet flange attachments to drainage piping.

D. Install counter-mounting fixtures in and attached to casework.

E. Install pedestal lavatories on pedestals and secured to wood blocking in wall.

F. 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. Comply with valve requirements specified in Section 220523 "General-Duty Valves for Plumbing Piping."

G. Install tanks for accessible, tank-type water closets with lever handle mounted on wide side of compartment.

H. Install toilet seats on water closets.

I. 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.

J. Install shower flow-control fittings with specified maximum flow rates in shower arms.

K. Install traps on fixture outlets.
   1. Exception: Omit trap on fixtures with integral traps.
   2. Exception: Omit trap on indirect wastes unless otherwise indicated.

L. Install disposer in outlet of each sink indicated to have a disposer. Install switch where indicated or in wall adjacent to sink if location is not indicated.

M. Install dishwasher air-gap fitting at each sink indicated to have air-gap fitting. Install. Connect inlet hose to dishwasher and outlet hose to disposer.

N. Install hot-water dispensers in back top surface of sink or in countertop with spout over sink.

O. Set shower receptors in leveling bed of cement grout.

P. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories and sinks. Comply with requirements in Section 220700 "Plumbing Insulation."

Q. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220510 "Basic Requirements for Plumbing."

R. Seal joints between plumbing fixtures, counters, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealers."

3.4 CONNECTIONS

A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

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

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

D. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories and sinks. Comply with requirements in Section 220700 "Plumbing Insulation."

3.5 ADJUSTING

A. Operate and adjust plumbing fixtures and controls, including but not limited to sensor operators. Replace damaged and malfunctioning fixtures, fittings, and controls.

B. Adjust water pressure at faucets to produce proper flow.

3.6 CLEANING AND PROTECTION

A. After completing installation of plumbing fixtures, inspect and repair damaged finishes.

B. Clean plumbing fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.

C. Provide protective covering for installed plumbing fixtures and fittings.

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

END OF SECTION 224100

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. HVAC demolition.
9. Equipment installation requirements common to equipment sections.
10. Painting and finishing.
11. Concrete bases.
12. Supports and anchorages.
13. Pre-demolition airflow measurements at all existing air handlers that are modified or replaced under this contract.
14. Removal/replacement of ceilings to accomplish work depicted. Repair/replace any damage to existing finishes to the satisfaction of the Architect.

1.3 DEFINITIONS

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

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

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

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

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to

outdoor ambient temperatures. Examples include installations within unheated shelters.

1.4 SUBMITTALS

A. Product Data: For the following:
1. Transition fittings.
2. Dielectric fittings.
3. Mechanical sleeve seals.
4. Escutcheons.
5. All new or modified equipment, air handlers, etc.
6. Ductwork.
7. Hydronic Piping.
8. Balancing devices.
9. VAV terminals.
10. Fire or Fire Smoke Dampers.
11. Fans.
12. Water coils.
13. As required by other Sections.

B. Welding certificates.

1.5 CONTRACTOR REQUIREMENTS

A. The Contractor shall be currently licensed by all appropiate federal, state, county and municipal agencies to furnish and install the type of work set forth in the Contract Documents and the limits of the Contractor's license shall be adequate to accommodate the size of the contract.

B. Within the scope of this project the Contractor and all of the Contractor's subcontractors shall apply for and obtain all necessary federal, state, county and muncipal permits, fees and inspections. Include the costs of all fees, inspections and permits within the Contractor's bid price. Provide copies of any or all permits to the Owner upon request.

1.6 COORDINATION

A. General: Refer to Division 1 for general coordination requirements applicable to the entire work. It is recognized that the Contract Documents are diagrammatic in showing certain physical relationships which must be established within the Mechanical work, and in its interface with other work including utilities and electrical work and that such establishment is the exclusive responsibility of the Contractor. The Drawings show diagrammatically the sizes and locations of the various conduit and raceway systems and equipment items and the sizes of the major interconnecting distribution, without showing exact details as to elevations, offsets, control lines, and installation details. All major feeders 1-1/2" diameter and over shall be shown on site and floor plans.

B. Arrange mechanical and electrical work in a neat, plumb and straight well organized and workmanlike manner with services running parallel with primary lines of the building construction and with a minimum of all manufacturer requirements and 12" above the ceiling.

C. The Contractor shall carefully lay out his work at the site to conform to the architectural and structural conditions, to avoid obstructions and to provide proper grading of lines. Exact locations of outlets, apparatus and connections thereto shall be determined by reference to detail Drawings, equipment Drawings, roughing-in Drawings, etc., by measurements at the building and in cooperation with other Contractors and in all cases shall be subject to the approval of the Engineer. Relocations necessitated by the conditions at the site or directed by the Engineer shall be made without any additional cost to the Owner or Engineer.

D. All conduit and boxes, except those in the various equipment rooms, in unfinished spaces or where specifically designated herein, or on the Drawings, shall be run concealed in furrings, plenums and chases. Wherever conditions exist which would cause any of these items to be exposed in finished spaces, the Contractor whose work is involved shall immediately call the situation to the attention of the Engineer and shall stop work in those areas until the Owner's Representative or General Contractor directs the resumption of the work. Submit for approval a Shop Drawing for any change in equipment placement, etc.

E. Equipment has been chosen to fit within the available space with all required Code and maintenance clearances and shall be installed as shown. Every effort has been made to also accommodate equipment of other approved manufacturers, however since equipment and access space requirements vary, the final responsibility for installation access and proper fit of substituted equipment rests with the Contractor with approval from Author by having jurisdiction

F. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for HVAC installations. Do not cut any building surfaces, structural, etc., without written approval from the Architect.

G. Coordinate installation of required supporting devices.

H. 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 "Openings."

I. The Drawings show diagrammatic locations of the various outlets and apparatus and equipment. Exact locations of these outlets and apparatus shall be determined by reference to the Architectural Drawings and to all detail Drawings, equipment Drawings, rough-in Drawings, etc., by measurements at the building, and in cooperation with the other trades. The Owner and Architect/Engineer reserve the right to make any reasonable change in location of any outlet or apparatus or equpiment before installation, without additional cost to the Owner.

J. Specifications: The specifications are intended to supplement the Drawings and it is not in the scope of the specifications to mention any part of the work which the Drawings are competent to fully explain. Conversely, any part of the work which the specifications are competent to fully explain, may not be mentioned on the Drawings

K. Disagreement: Disagreement between the Drawings or specifications or within the Drawings or specifications shall be estimated using the better quality or greater quantity of material or installation, and a request for information shall be made to the Engineer.

L. Coordination Drawings:
1. The Contractor shall prepare coordination computer aided drawings (CAD) of the installation of the mechanical (HVAC, plumbing and fire protection work using AutoCAD 2004 software, or later edition. Prepare drawings at a mimimum scale of 1/8" = 1'-0", or at 1/4" = 1'-0" or at ½" = 1'-0" if necessary to provide the detail necessary to clearly show all of the work.
2. The Contractor can obtain Electronic copies as outlined in the Record Drawings Section hereinafter.
3. Coordiantion CAD drawings shall include the areas specified below and for a distance of fifty feet beyond in all directions. Provide coordination CAD drawings for:
   a. All Air Handling Unit Rooms
   b. All floor to floor piping or HVAC ductwork risers for the full length of the risers
   c. All housekeeping concrete pads showing pad thickness, reinforcing, doweling
4. The coordination CAD drawings shall show:
   a. Plan view and at least two (2) section through all mechanical equipment rooms and areas listed above.
   b. Architectural features.
   c. Column lines.
   d. Text shall be minimum height of 1/8" when plotted at full scale.
   e. Provide graphic scales – do NOT use stated scales.
   f. Provide separate layer(s) and/or "Xrefs" for each discipline (mechanical HVAC, plumbing, electrical, fire protection sprinkler, etc).
   g. Room name, room number and NORTH ARROW
   h. Mechanical equipment and equipment service/maintenance access areas
   i. Provide elevation of each piece of equipment in each mechaical room, air handling unit room, roof, etc.
   j. Piping shall be drawn two (2) line.
   k. Ductwork shall be drawn two (2) line.
   l. Electrical work (electrical equipment such as panels, transformers, etc. as well as conduit greater than 1" in size) and required clearances
   m. Fire protection sprinkler work.
5. The Contractor shall maintain these coordiantion CAD drawings throughout the course of the project making edits/updates to the drawings as necessary to accurately depict the installation of the work.
6. The Contractor may submit these drawings in accordance with the Record Drawings Section hereinafter.

PART 2 - PRODUCTS

2.1 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.

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

2.2 JOINING MATERIALS

A. Refer to individual Division 23 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: 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.

2.3 DIELECTRIC FITTINGS

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

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

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

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

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

2.4 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve. Fire rated mechanical sleeve sealing systems shall have the Factory Mutual Fire Approval. Mechanical sleeve sealing systems shall be designed for use as a permanent seal with seal emements compounded to resist aging, ozone, sunlight, water and a wide range of chemicals. Mechanical sleeve sealing systems shall allow for some angular and off center pipe conditions and still seal effectively.
1. Sealing Elements for Normal Applications: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Sealing Elements for Fire Seal (Fire Rated) Applications: Silicone (Grey) interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Molded glass reinforced Nylon Polymer for normal applications. For fire and Hi-Temp service, pressure plates shall be steel with 2-part Zinc Dichromate Coating. 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.

B. Refer to paragraph 3.11 "FIRE STOP SYSTEMS".

2.5 SLEEVES

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

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

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

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

2.6 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. Split-Plate, Stamped-Steel Type: With concealed hinge, set screw or spring clips, and chrome-plated finish.

2.7 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
   1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
   2. Design Mix: 5000-psi , 28-day compressive strength.
   3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS – COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 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, 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 required 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 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.
g. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and set screw.

M. Install sleeves for pipes passing through 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 in finished service spaces.
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.

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. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Also comply, as specified herein.

Q. Verify final equipment locations for roughing-in.

R. 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. 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 provide adequate space per manufacture requierments as minmum and access to maintain and service equipment and to facilitate service, maintenance, and repair or replacement of components. Install equipment with adequate space and access to comply with code requirements and to comply with manufacturer's installation instructions. 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.

E. New, as well as, refurbished equipment must be disassembled in order to pass through existing building openings; refer to notations on the drawings. If removal of existing glazing, door frames, walls, etc., is required, this shall be executed only after written approval is obtained from the Architect.

3.5 USE OF NEW SYSTEMS DURING CONSTRUCTION

A. The Contractor is NOT allowed to use the new or refurbished HVAC system or any portion or part of the HVAC system during the construction phase of the project without the expressed written permission of the Owner.

B. If the Owner should allow the Contractor to use the HVAC system during the construction phase of the project the Contractor shall furnish and install the following provisions:
   1. Furnish and install high efficiency (60 to 65% efficient), rigid, mini-pleated filters in all air handling units (AHUs). Replace filters with new clean filters at maximum one (1) month intervals.
   2. Furnish and install minimum 1-1/2" thick, flexible filter media over ALL return air openings (including ceiling return air grilles, etc.) and change at one (1) month intervals.
   3. If the Owner does allow the Contractor to use the HVAC system during the construction phase and if the Contractor does use the HVAC system during the construction phase then at the end of the use period by the Contractor the Contractor shall clean all coils in all operated AHUs. This shall mean that the Contractor steam clean and/or chemically clean all coils and all condensate drain pans in all operated AHUs. At the end of the use period by the Contractor during the construction phase the Contractor shall furnish and install a complete new set of filters in each operated AHU when the system is turned over to the Owner. It is the intent of this specification to provide the Owner with a new HVAC system that is as clean as is reasonably possible.

3.6 PAINTING

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

3.7 CONCRETE BASES (HOUSEKEEPING PADS)

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions.
   1. Construct concrete bases of dimensions required to extend a minimum 6" on all sides of the supported unit.
   2. Install dowel rods to connect concrete base to existing concrete floor. Unless otherwise indicated, install dowel rods on 12-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 4000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Concrete".
   8. Modify, remove, replace existing pads to comply with new equipment/layouts. Where existing pads are removed, grind down to a smooth finish to match the surrounding existing concrete floor. All pads existing outside of new/refurbished equipment dimensions +6" each way are to be removed.

3.8 INSTALLATION

A. All equipment shall be installed in a manner to permit access to parts requiring service without disassembly of piping mains and other equipment. Access panels or doors shall be coordinated with the Architect and provided where necessary to permit valve equipment service or removal. Refer to the architectural specifications for additional requirements.

B. Any large piece of apparatus which is to be installed in any space in the building, and which is too large to permit access through stairways, doorways, or shafts shall be brought to the job disassembled, and re-assembled inside the Mechanical Rooms. Following placement in the space, such apparatus shall be thoroughly and completely protected against damage.

C. Minimize installation of water piping in proximity of rooms housing telephone equipment, fire alarm systems, transformers, or other electrical equipment. Do not install water piping within, or above ceilings of these rooms.

3.9 CUTTING AND PATCHING

A. Where it becomes necessary to cut through any wall, floor, or ceiling to permit installation of any work under this section of the Specifications or to repair any

defects that may appear, up to the expiration of the guarantee period, such cutting shall be done under the supervision of the Architect by the Contractor. The Contractor shall not be permitted to cut or modify any building surfaces, slabs, etc., without the written permission of the Architect.

B. Patching of all openings cut by the Contractor, or repairing of any damage to the work of other trades occasioned by cutting operations, or occasioned by the failure of any part of work installed under this contract, shall be performed by the trade whose work is involved, but shall be paid for by the Contractor.

C. Any openings cut through exterior walls or roofs shall be provided with suitable covers, while they are left open, to protect the property or materials involved and maintain security.

3.10 FIRE STOP SYSTEMS

A. Seal all pipe, conduit, cables, spare sleeves, etc. penetrations through roofs and fire-rated walls and floors with factory made devices or with manufactured fill, void, or cavity materials classified by Underwriters Laboratories (UL) as a "through-penetration fire stop" and which meet the following requirements:
1. Maintain the fire resistance rating of the penetrated building construction. Refer to the architectural Contract Documents for fire ratings of general construction.
2. Comply with the requirements of ASTM E814, UL 1979, ASTM E119, UL 723, ASTM E84 and UL 263 for all types of penetrations sealed.
3. Do not exhibit excessive shrinkage, which would permit transmission of flame, smoke, gasses, vermin and/or water prior to exposure to a fire condition.
4. Mastics used to seal surface of fire stop system shall be non-hardening.
5. Shall accommodate expansion and contraction of the penetrating element, i.e. pipe etc., without reducing its effectiveness as a smoke barrier and/or water seal.

B. Submittal data for fire stop systems shall include applicable UL System numbers.

C. Installing Contractor shall submit evidence that he has been trained by an authorized fire stop system manufacturer's representative prior to beginning the installation. The manufacturer's representative shall visit the jobsite and visually observe representative samples of each of the various fire stop systems employed on this project, during and after installation, and provide a written certification that the installations observed appear to have been installed in accordance with the manufacturer's recommendations and UL requirements.

D. Sealing of conduits that extend through fire-rated walls from ends of cable tray shall be performed after conductors/cables have been installed.

E. Acceptable Manufacturer's Products: If it complies with these Specifications, one of the following manufacturers' fire stop sealing components/systems will be acceptable:
1. 3M Fire Protection Products.
2. General Electric and Specified Technologies, Inc. SpecSeal systems.
3. Nelson Flameseal Fire Stop Putty (dry locations only).
4. Specified Technologies, Inc.

5. Tremco Fire Resistive Joint System utilizing "Dymeric" sealant and Cerablanket-FS mineral filler.

3.11 HOISTING, SCAFFOLDING, AND TRANSPORTATION

A. The Contractor shall provide his own hoisting facilities and scaffolding to set his materials and equipment in place, as indicated on Drawings and for subsequent cleaning, testing, and adjusting.

B. The Contractor shall provide necessary transportation to facilitate the delivery of all materials, equipment, tools, and labor to the job, in accordance with intent of these documents.

3.12 CLEANING

A. The Contractor shall, at all times, keep the premises free from accumulations of waste material or rubbish caused by him, his employees, or his work. This debris shall be removed, not only from the building, but also from the project site.

B. At completion of the job, the Contractor shall remove all of his tools, scaffolding, and surplus materials. He shall leave the area "broom clean".

3.13 ELECTRICAL WIRING OF MOTORS AND EQUIPMENT

A. Unless specifically shown, indicated, or specified to the contrary, each item shown or required by the Mechanical Drawings or specified in the Mechanical Specifications shall be accompanied by all motors and starting and controlling equipment necessary for the items proper operations. These motors shall be integrally attached to and/or installed with their associated equipment item and electrically connected as specified in Division 26 - Electrical. Equipment controlled from motor control centers shall be supplied with motors only. Motor control centers are specified in Division 26 and shown on the Electrical Drawings.

3.14 WORK IN EXISTING BUILDINGS

A. The work to be performed on this project occurs within an existing occupied building. Noisy, dusty, fume emitting and/or other construction operations required for work which may disturb Airport operations are unacceptable.

B. The Contractor and the Division 23 Subcontractor shall carefully examine the existing building and review all of the Contract Documents prior to submitting his bid in order to determine the extent of work required to be completed under this Division. Failure to conduct this examination shall not relieve the Contractor of the responsibility to perform all the work required for a complete and fully operational installation satisfactory to the Owner.

C. Contractor shall include in the bid price cost of relocation or removal of existing equipment and systems required for complete installation of the new systems indicated in the Contract Documents. In submitting his bid, the Contractor agrees to accept all existing site conditions not specifically accepted. Where Contract Documents conflict with existing field conditions, a record of the field conditions shall be provided in writing to the Architect.

D. The Contractor shall be responsible for loss or damage to the existing facilities caused by him and his workmen, and shall be responsible for repairing or replacing such loss or damage. The Contractor shall send proper notices, make necessary arrangements, and perform other services required for the care, protection and service and in service maintenance of all plumbing, heating, air conditioning, and ventilating services for the new and existing facilities. The Contractor shall erect temporary barricades, with necessary safety devices, as required to protect personnel from injury, removing all such temporary protection upon completion of the work.

E. All new work shall be coordinated with existing space constraints. All equipment and material shall be fabricated such that complete systems may be disassembled into sections suitable for lifting in the existing freight elevator or construction hoist and fit through existing passageways without unauthorized modifications of the existing building construction.

F. The Contractor shall provide temporary services to all existing facilities as required to maintain their proper operation when normal services are disrupted as a result of the work being accomplished under this project.

G. Where existing construction is removed to provide working and extension access to existing utilities, Contractor shall remove doors, piping, conduit, outlet boxes, wiring, light fixtures, air conditioning ductwork and equipment, etc., to provide this access and shall reinstall same upon completion of work in the areas affected.

H. Coordinate new work in existing building in a manner that allows proper phasing of the work without disruption of Owner's activities in occupied spaces. All work scheduled in occupied areas MUST BE COORDINATED WITH AND APPROVED BY THE OWNER prior to commencement of the work.

I. The Contractor shall use construction methods and materials which shall not adversely affect the indoor air quality of the occupied areas. Contractor shall furnish and install temporary constructions and modify existing air handling system where required to isolate areas under construction from surrounding occupied areas to control the migration of dust or fumes. If deemed necessary by the Owner, the Contractor shall furnish and install temporary supply and/or exhaust fan to negatively pressurize the construction area relative to adjacent occupied areas.

3.17 COMMUNICATIONS AND ELECTRICAL EQUIPMENT ROOMS PRECAUTIONS

A. In general, piping shall not be installed in any switchgear, transformer, elevator equipment, telephone, communication or electrical equipment room unless this piping serves only that room.

B. Sprinkler heads and piping within main communication equipment rooms and rooms having electrical gear shall be provided with shields and/or deflectors where required by the AHJ or Owner to protect electrical and/or communications equipment.

C. Piping shall not be installed above switchboards, panelboards, control panels, motor control centers, individual motor controllers etc. Piping shall not be installed above bus duct unless otherwise show on the Drawings.

D. Coordinate with Division 26 Contractor to ensure the above listed precautions are met.

PART 4 – REGULATORY REQUIREMENTS

4.1 AUTHORITY HAVING JURISDICTION

A. Where alterations and/or deviations from the Contract Documents, i.e. Drawings and Specifications, are required by the AHJ, report the requirements to the Architect and secure his written approval before starting the alteration.

B. Modifications to the Division 23 work required by the AHJ shall be made by the Contractor without additional cost to the Owner.

4.2 CODES AND REFERENCE STANDARDS

A. All materials and workmanship shall comply with the requirements of the Building, Mechanical, Electrical, Plumbing, Fire, Accessibility, and Energy Codes adopted by the City of San Antonio, including all amendments, applicable laws and ordinances and supplementary rules and interpretations. Where Contract Document requirements exceed Code requirements and are permitted under the Code, the Contract Documents shall govern.

B. In all cases where Underwriter's Laboratories, Inc. have established standards for a particular type material, such material shall comply with these standards or other nationally recognized testing standards acceptable to the Authority Having Jurisdiction. Evidence of compliance shall be the UL "label" or "listing" under Re-Examination Service.

C. The following specific codes and standards shall apply to this project:
1. ADA Accessibility Guidelines for Buildings and Facilities, 1991 (ADAAG) with current amendments.
2. Americans with Disabilities Act, Part III, 28 CFR 36, July 26, 1991 (ADA).
3. Building Services Piping (ASME/ANSI B31.9).
4. Elimination of Architectural Barriers Act, Texas Department of Licensing and Regulations, Texas Civil Statutes, Article 9102,
5. Energy Conservation Standard for New State Buildings.
6. Governing Fire Department requirements.
7. National Fire Codes (NFPA), current edition.
8. National Electrical Code (NFPA 70), latest edition.
9. Occupational Safety and Health Act (OSHA).
10. Current, applicable safety Code for Elevators and Escalators (ASME A17.1).
11. Standards for Access to the Handicapped (ANSI 117.1).
12. Texas Accessibility Standards (TAS), Texas Department of Licensing and Regulations (TDLR), Architectural Barriers Act, Article 9102, Texas Civil Statutes, effective April 1, 1994.

13. Texas Boiler Law, Chapter 755, Health and Safety Code, Texas Department of Licensing and Regulations.
14. Current Applicable International Building code with local amendments.
15. Current Applicable International Mechanical code with local amendments.
16. Current Applicable International Fire code with local amendments.
17. Current Applicable International Energy conservation code with local amendments.
18. Current Applicable Uniform Plumbing code with local amendments.
19. Current Applicable National Electric code with local amendments.
20. Current Applicable Supplemental with local amendments.

D. Refer to Division 01 and the Division 23 Specification Sections hereinafter for additional applicable regulatory requirements.

4.3 OWNER'S RULES AND REGULATIONS

A. Comply with Owner's rules and regulations, as well as Airport Security requirements, as they apply.

4.4 DISCREPANCIES

A. The Contract Documents are intended to comply with the aforementioned rules and regulations; however, some discrepancies may occur. Where such discrepancies occur, the Contractor shall immediately notify the Architect and the Engineer in writing of said discrepancies and apply for an interpretation.

B. Should the discovery and notification occur after the execution of the Contract, any additional work required for compliance with said regulations shall be paid for as covered by Division 01, providing no work or fabrication of materials has been accomplished in a manner of noncompliance.

C. Should the Contractor fabricate and/or install materials and/or workmanship in such a manner that does not comply with the applicable codes, rules and regulations, the Contractor who performed such work shall bear all costs arising in correcting these deficiencies to comply with said rules and regulations.

E. Clarification: Clarification shall be obtained before submitting a proposal for the Work under this Division as to discrepancies or omissions from the Contract Documents or questions as to the intent thereof.

F. Detailed Instructions: Should it appear that the work hereby intended to be done or any of the materials relative thereto, is not sufficiently detailed or explained in the Drawings or Specifications, then the Contractor shall submit a request for information to the Engineer for such further Drawings or explanations as may be necessary before proceeding, allowing a reasonable time for the Engineer to respond. The Contractor shall conform to this additional information as a part of the Contract without additional cost to the Owner or Engineer.

G. Interpretations: Should any doubt or question arise respecting the true meaning of Drawings or Specifications, reference shall be made to the Engineer, whose written decision shall be final and conclusive. Undocumented statements will not be accepted as an excuse for inferior work.

H. Contractor Agreement: Consideration will not be granted for misunderstanding of the amount of work to be performed. Submission of a bid conveys full Contractor agreement of the items and conditions specified, shown, scheduled, or required for completion of the project.

END OF SECTION 230500

SECTION 230510 - BASIC REQUIREMENTS 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.

B. Drawings and Specifications
   1. Division 23 specifications are written in imperative and streamlined format. This imperative language is directed to the Contractor. The word "shall be" shall be included by inference where a colon (:) is used within sentences and phrases.
   2. Where utilized in these specifications, the following definitions of the words install, furnish and provide apply.
      a. Install: To set in place in position for service.
      b. Furnish: To supply.
      c. Provide: To install and furnish.

C. Codes and Standards.
   1. Work shall comply with the local city codes and ordinances, the regulations of state authorities having lawful jurisdiction and the codes, statues and reference standards identified within these Specifications. These Specifications shall not be construed as negating the regulations or requirements of lawful jurisdictions.
   2. Where Specifications require materials or equipment exceeding the minimum requirements of applicable codes and ordinances, the requirements of these Specifications shall take precedence.

1.2 SUMMARY

A. The requirements set out in Bidders Documents, Contract Forms, General Conditions, Supplementary General Conditions and Special Conditions apply to all work specified in the sections of this division.

B. A division is a group of related sections, and a section covers one portion of the total work or requirements. It describes a particular material or product and its installation.

A section does not necessarily relate to the work accomplished by a single subcontractor. It is not the intent of the Specifications to define the work of individual trades so that a contractor can simply hand out various sections to selected subcontractors. Each contractor will subdivide the work differently among subcontractors. It is not possible for the Specifier to know which contractor may be the successful bidder and how the project will be managed.

For the above reasons, the text of sections, and the Specifications in general, are always addressed to the Contractor and not to subcontractors. The Contractor signs an agreement with the Owner to construct the project and

therefore is the only one responsible to the Owner. Responsibility for the total project remains with the Contractor no matter how the work is divided among subcontractors.

C. Work covered by the Mechanical Sections of these Specifications shall include the furnishing of all materials, labor, taxes, transportation, safe working conditions, tools, permits, fees, inspections, utilities and incidentals necessary for the complete and operable installation of all mechanical systems.

D. Under these Contract Documents, the Contractor shall provide an installation that is complete in every respect. The Contractor shall include additional details or special construction as required for work indicated or specified in this section or work specified in other sections. It shall be the responsibility of the Contractor to provide all material and equipment which is usually furnished with such systems in order to complete the installation, whether mentioned or not.

E. The Contractor shall be responsible for the coordination and proper relation of the work to the building structure and to the work of all trades. The Contractor shall visit the premises and become familiar with the existing site conditions, and all details of the work and the working conditions and to verify all dimensions and elevations in the field. The Contractor shall advise the Architect and Engineer of any discrepancy prior to bidding. The submission of bids shall be deemed evidence of the Contractor's site visit, the verification and coordination of all existing conditions, and the inclusion of all considerations related to the existing conditions.

F. The responsibility for the furnishing of the proper equipment and/or material and the responsibility for seeing that it is installed as intended by the manufacturer rests entirely upon the Contractor. The Contractor shall consult and request advice and supervisory assistance from the representative of the specific manufacturer for proper installation, operation, and startup. The manufacturers' published instructions shall be followed for preparing, assembling, installing, erecting, and cleaning manufactured materials or equipment. The Contractor shall promptly notify the Architect and Engineer in writing of any conflict between the requirements of the contract documents and the manufacturers' directions and shall obtain the Architect's and Engineer's instructions before proceeding with the work. Should the Contractor perform any such work that does not comply with the manufacturer's directions or such instructions from the Architect and Engineer, he shall bear all resulting costs that may arise from any system or equipment deficiencies.

1.3 DRAWINGS AND SPECIFICATIONS

A. These Specifications are accompanied by Drawings of the building and details of the installations indicating the locations of equipment, piping, ductwork, outlets, light fixtures, etc. Items specifically mentioned in the Specifications but not shown on the Drawings and items shown on the Drawings but not specifically mentioned in the Specifications shall be installed by the Contractor under the appropriate section of work as if they were indicated by both.

B. If departures from the Drawings are deemed necessary by the Contractor,

details of such departures and the reasons therefor shall be submitted to the Architect and Engineer for review. No departures shall be made without prior written acceptance of the Architect and Engineer.

1. The interrelation of the Specifications, the Drawings, and the schedules is generally as follows: The Specifications determine the nature and setting of the several materials, the Drawings establish the quantities, dimensions, and details, and the schedules give the performance characteristics.

1.4 SUBMITTALS

A. After the Contract is awarded, but prior to proceeding with the Work, the Contractor shall obtain, check, certify, and submit complete Shop Drawings and Brochures from Manufacturers, Suppliers, Vendors, etc., for all materials and equipment specified herein. Submit Shop Drawings and Brochures in sufficient time so as not to impede the progress of Work. Four weeks will be required for the processing of Shop Drawings and Brochures in the Engineer's office, exclusive of transmittal time. This time shall be considered by the Contractor when scheduling submittal data. After the Contract is awarded, the Contractor will advise the Engineer in writing of the schedule for submission of shop drawings and product data and the persons authorized to sign submittal data on behalf of the Company.

B. The Engineer's review of Shop Drawings and Brochures shall not relieve the Contractor of the responsibility for dimensions, errors that may be contained therein, or deviations from Contract Document requirements. It shall be clearly understood that the Engineer's noting some errors but overlooking others does not grant the Contractor permission to proceed in error. Contractor shall refer to applicable Section in Division 23 for all test and balance rough-in requirements. Contractor shall ascertain all equipment electrical requirements are coordinated with Division 26 and electrical drawings. Contractor shall confirm all shop drawings reflect coordination with structural and all other trades and are free of interferences. Regardless of any information contained in the Shop Drawings, the requirements of the Contract Documents shall govern and are not waived or superseded in any way by the submittal data review.

C. Before submission of Shop Drawings and Brochures, the Contractor shall certify that each Shop Drawing and each item of material or equipment complies with the Contract Documents for this Project. Such certification shall be made by the Owner, a Partner, a Corporate Officer of the Contractor, or by a person duly authorized to sign for the Contractor. Unless so certified, Shop Drawings and/or Brochures will be returned for resubmittal. Certifications shall be in the form of rubber stamp impressions or typed letter which states:

> I hereby certify that this Shop Drawing and/or brochure and the equipment and material shown on this Shop Drawing and/or Brochure complies in all respects (except as noted*) with the requirements of the Contract Documents for this Project. I further certify that all data shown herein as to performance, dimensions, construction, materials, and other pertinent items are true and correct.
>
> (Name of Contractor) _____
>
> Signed _____
>
> Position _____
>
> Date _____
>
> * Refer to exception requirements herein.

D. 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 Sheet or Brochure; name and location of the building; names of the Architect, Engineer, Contractor, Manufacturer, Supplier, Vendor, etc., the date of submittal; and the date of each correction and revision. So far as is practical, each Shop Drawing and/or Brochure shall bear a cross-reference note to the sheet number or numbers of the Contract Drawings and Specifications showing the same work. Shop Drawings and Brochures shall be prepared as follows:

1. Shop Drawings: Drawings shall be newly prepared and not reproduced from the contract documents, drawn to a scale that can be easily read and shall contain sufficient plans, elevations, sections, and isometrics to describe clearly the items in question. Drawings shall be prepared by a draftsman skilled in this type of work. All piping, equipment layouts, ductwork and similar Shop Drawings shall be drawn to at least 1/4" = 1'-0" scale.
2. Brochures: Brochures submitted to the Engineer shall be published by the Manufacturers and shall contain complete and detailed engineering and dimensional information to show that the equipment will fit into the allotted space.

3. Brochures submitted shall contain only information which is relevant to the particular equipment or materials to be furnished. Do not submit catalogs that describe several different items other than those items to be used unless all irrelevant information is marked out or relevant information is clearly marked.

E. The submittal format shall follow the Specifications format with a submittal required for each section of Division 23. The submittal shall be contained in a three-ring hard back binder. Copies of each submittal shall be three-hole punched and arranged (or folded if required) for the Engineer's filing convenience. Provide one copy of updated TABLE OF CONTENTS and progressive-tabbed index sheets also for the Engineer's filing convenience.

F. Submittal data for each section must be complete. Partial submittals will not be reviewed. To the greatest extent possible all sections shall be submitted with the first submission. No more than three additional submissions will be allowed to complete the submittal package.

G. Each page of the submittal shall be a clear copy or scan, indicating items and options proposed for use in the project with a graphical arrow. Items included on a submittal page that are not proposed for use shall be deleted with strike-through or other acceptable method that clearly distinguishes the proposed from non-relevant information.

H. Subject to the requirements in Division 1, at the Contractor's option, submittals may be provided in PDF form
   1. All format and informational requirements for submittals in binders apply to PDF submittals.
   2. Multiple files may be submitted, however, these must be organized into a consistent format.
   3. In lieu of tabs, the PDF submittal shall include a table of contents with page numbers listed for the beginning of each section.
   4. Additionally, the PDF shall be formatted to include tab or chapter shortcuts, labeled with the associated specification section. These shortcuts shall allow the reader to jump to a tab or chapter associated with beginning of each specification section with a single action.

I. Mechanical contractor shall be responsible for submitting a coordinated RCP shop drawing showing ALL ceiling mounted devices such as the lights, air devices, fire alarm devices, special systems devices, and sprinkler heads. Drawing shall be submitted to Architect/Engineer for review prior to installation of devices.

J. Unless a greater number is indicated within the Architectural Sections of these specifications, submit six (6) copies of all Brochures for review. Submit one (1) reproducible and one (1) blueprint of shop drawings for review. Comments will be made on the reproducible to facilitate copying. One set will be retained by the Engineer, one (1) set by the Architect for record purposes, and two sets for the Owner's Operating and Maintenance Manuals.

K. Minimum size of submittal data shall be 8-1/2 x 11".

L. Any submittal that is disapproved must be resubmitted within two (2) weeks following notification of such disapproval. If no satisfactory material is submitted within the two-week period, the Architect and Engineer reserves the right to require the Contractor to furnish items exactly as described in the Contract Documents.

M. No allowances will be made for submittals which are not made in a timely fashion or which are turned down because they do not meet the specifications. Should delivery problems arise due to the above, affecting the completion time of the project, the Contractor will furnish and install acceptable alternates until the proper materials arrive and then replace the alternate materials with the approved materials, all at no cost to the Owner. If the Contractor is not able to furnish an acceptable alternate until the proper materials arrive, he will assume all costs for furnishing and installing all alternates as directed by the Architect and/or will pay a suitable penalty for the inconvenience experienced by the Owner. This penalty will be set by the Owner based on the particular circumstances.

N. Only equipment and material brands which are specifically mentioned in the following sections of Division 23 will be considered during the submittal process.

1.5 RECORD DRAWINGS

A. The Contractor shall maintain on a daily basis at the project site a complete set of "Record Drawings", reflecting an accurate dimensional record of all buried or concealed work. The "Record Drawings" shall also consist of a set of blueline or blackline prints of the final "Signed Off" Contractor's Coordination Drawings" prepared by the Subcontractors. In addition, the "Record Drawings" shall be marked to show the precise location of concealed work and equipment, including concealed or embedded piping and valves and all changes and deviations in the Mechanical work from that shown on the Contract Documents. This requirement shall not be construed as authorization for the Contractor to make changes in the layout or work without written definite instructions from the Architect and Engineer.

B. Daily Record Drawings: The Daily "Record Drawings" shall consist of a set of blueline or blackline prints of the Contract Drawings for this Division with the Engineer's seal and Engineer's firm name removed or blacked out. Final "Record Drawings" shall be electronic CAD files.

Prior to commencing work, the Contractor shall purchase from the Architect and Engineer a set of blueline or blackline prints to be used for the daily "Record Drawings."

C. Final Record Drawings and BIM Model:
1. Prior to completion of the construction, the Contractor may purchase electronic copies of the floor plans in AutoCAD format for use in developing the Record Drawings from the Engineer. These electronic drawings will be made available at a cost of $75.00 per sheet providing an Officer of the Contractor's firm signs a liability release.
2. Final Record Drawings in AutoCAD format shall comply with the following:
   a. A CADD file that matches the plotted sheet shall be provided to

CNG Engineering, this sheet may contain Xreferences linking to the full size design files. The filename of this plotted sheet shall match the sheet number represented in the title block of that sheet.

b. All CADD files are to be drawn to full size scale, and all elements are to be drawn full size, except where size constraints will not allow the exact dimension, in this case a standard symbol should be used in its place, i.e., an electrical outlet should be a symbolic symbol, whereas a 2'x4' light fixture should be drawn 2'x4'.

c. Reproducible hardcopy plots shall accompany transfer of electronic media. Verify plotted sheet size with CNG Engineering prior to plotting. Each plotted sheet shall have a corresponding electronic CADD file associated with it.

d. All CADD design file documents are to be drawn relative to each other with one common origin point universally defined as absolute zero (0,0,0) on a plan view.

e. The CADD layering scheme shall be such that specific design elements and text can be isolated via layer ON/OFF control. A printed list shall be provided detailing layer name and description of design elements for each layer.

f. Contractor shall provide to CNG Engineering all non-standard AutoCAD fonts used in the CADD documents. If specialized fonts with characters of ASCII value greater than 126 are used, Contractor shall convert them to graphic lines, circles, arcs, etc. and or blocks, removing the special coded text string.

g. When X-references are used in the CAD drawings, all support CAD drawings shall remain as X-ref attachments (not bound) to ensure uniformity of layer names, text style names, block names, linetypes names and origin base point. A diagram shall be provided, detailing the exact flow of all X-ref's. Remove all path names from all attached Xref's so that all files can be in one directory and be resolved into AutoCAD.

h. All media shall be accompanied by a printed indexed listing of the contents. DOS file sets greater than 1.4 MB (one 3.5" diskette) shall be compressed using PKZIP, PKPAK, or self-extracting archive files.

i. If the amount of compressed CAD data exceeds fifty (50) megabytes, contact the CADD/Computer Coordinator at CNG Engineering for further arrangements for transfer of electronic data.

j. Contractor shall provide CAD files and reproducibles of Record Drawings within 15 working days of notification from CNG Engineering, in a form satisfactory as described above.

k. Engineer and/or Owner reserves the right to review CAD files of Record Drawings at any time during construction. If this agreement is terminated, the Contractor shall promptly furnish CAD files as is to that date to CNG Engineering and/or Owner.

D. Record dimensions shall clearly and accurately delineate the work as installed, including horizontal and vertical offsets (with elevations) of underground services. Locations shall be suitably identified by at least two (2) dimensions to permanent structures.

E. The Contractor shall mark all "Record Drawings" on the front lower right hand corner with a rubber stamp impression that states the following:

"RECORD DRAWINGS (3/8" high letters) To be used for recording Field Deviations And Dimensional Data Only." (5/16" high letters)

F. Upon completion of work, the Contractor shall certify the "Record Drawings" for correctness by signing the following certification:

CERTIFIED CORRECT (3/8" high letters) (Name of General Contractor By:_____ Date:_____ (Name of Mechanical, Plumbing, Fire Protection or Temperature Control Subcontractor) By:_____ Date:_____

G. Prior to final acceptance of the Work of this Division, the Contractor shall submit properly certified "Record Drawings" to the Architect and Engineer for review and shall make changes, corrections, or additions as the Architect and Engineer may require to the "Record Drawings." After the Architect and Engineer review, one set of reproducible mylars and one (1) set of electronic CAD files (AutoCAD) "Record Drawings" shall be delivered to the Owner.

1.6 RECORD SPECIFICATIONS

A. Maintain and submit Record Specifications as required in Division 01 Specification Section for CONTRACT CLOSEOUT.

1.7 BIM MODEL (Reviewer to modify)

A. Prior to final acceptance provided applicable BIM model showing installation. The quality and certification requirements for Section 1.5 RECORD DRAWINGS apply to this Section 1.7 BIM MODEL.

1.8 SPACE LIMITATIONS

A. Equipment has been chosen which will fit into the physical spaces provided and indicated, allowing ample room for access, servicing, removal and replacement of parts, etc. Adequate space shall be allowed for clearance in accordance with the Code requirements and the requirements of the local inspection department.

B. In the preparation of Drawings, a reasonable effort to accommodate approved Equipment Manufacturers' space requirements has been made. However, since space requirements and equipment arrangement vary according to each Manufacturer, the responsibility for initial access and proper fit rests with the Contractor.

C. Physical dimensions and arrangements of equipment to be installed shall be subject to the Architect's review.

D. All mechanical equipment specified herein and shown on the Drawings is schematic. Prior to beginning any work whatsoever, the Division 23 Mechanical Contractor shall furnish as a part of the mechanical equipment submittals, scaled drawings of all proposed mechanical equipment, indicating accurate sizes and characteristics of proposed equipment, as well as clearances, piping routes, and all other details as required to allow the Engineer, Architect, and Owner the opportunity to approve the proposed layout and equipment. If the arrangement is not acceptable, then the proposed equipment and/or arrangement shall be modified or changed as required to be made acceptable at no additional cost to the Owner.

1.9 CONTRACTOR'S COORDINATION DRAWINGS

A. The Contractor and all Subcontractors shall prepare a complete set of "Coordination Drawings" indicating the equipment actually purchased and the exact routing for all lines such as piping, conduit and ductwork. The elevation, location, support points, load imposed on the structure at support and anchor points, and size of all lines shall be indicated. All beam penetrations and slab penetrations shall be indicated and sized and shall be coordinated. This requirement for "Coordination Drawings" shall not be construed as authorization for the Contractor or Subcontractor to make any unauthorized changes to the Contract Drawings. All Design Drawing space allocations shall be maintained, such as ceiling height, chase walls, equipment room size, etc., unless proper written authorization is received from the Architect to change them.

1.10 OPERATION AND MAINTENANCE MANUAL

A. Prepare and submit to the Architect and Engineer for delivery to the Owner two (2) sets of an indexed manual with complete technical data for every piece of equipment and material installed under this Contract.
   1. Complete mechanical submittals that were approved for the project.
   2. Manufacturer's installation instruction brochures.
   3. Manufacturer's local representative and/or distributor's name and address.

4. Manufacturer's operation and maintenance brochures.
5. Manufacturer's internal wiring diagrams.
6. Contractor's installation wiring diagrams.
7. Control system installation Drawings and typed control sequences.
8. Replacement part number listings and/or descriptions including prices and source of supply.
9. Lubrication materials required, with instructions.
10. Valve tag list and schematic diagram.
11. All warranties and guarantees.
12. Testing and Balancing Report.
13. Commissioning Report (Bind in separate three-ring binder).

B. These manuals shall include all of the listed data bound into a permanent hard-back binder identified on the cover as "Operation and Maintenance Manual". Provide a title page listing the name and location of the Building, the Owner, the Architect, the Engineers, the General Contractor, and the Trade-Contractors installing equipment represented in the brochure.

C. Contents of the manual shall be grouped in sections according to the various sections of Division 23, and shall be listed in a Table of Contents.

1.11 QUALITY ASSURANCE

A. Should the Drawings disagree in themselves or with the Specifications or if the Specification disagree in themselves or with the various codes and regulations, the better quality and more stringent and greater quantity of work and materials shall be assumed and estimated, and unless otherwise directed by the Architect and Engineer in writing, shall be performed or furnished. In case the Specifications should not fully agree with the schedules, the latter shall govern. Figures indicated on Drawings govern scale measurements and large scale details govern small scale Drawings.

B. The Contractor shall comply with all applicable city, county, state, or federal rules, codes and ordinances.

C. None of the terms or provisions of this Specification shall be construed as waiving any rules, regulations, or requirements of these authorities.

D. A competent foreman or superintendent, initially approved by the Architect and Engineer shall be kept by the Contractor at the building to receive instructions and to act for the Contractor. Once this superintendent has been approved, no change shall be made without approval of the Architect and Engineer. Architect's and Engineer's and/or Owner's representatives shall have the right to observe the work at any time. The Contractor shall have a representative present when his work is being observed, and he shall give assistance, as may be required, to the Architect's and Engineer's representative. Recommendations made shall be promptly carried out, and all unsatisfactory material and/or workmanship shall be replaced at once, to the satisfaction of the Architect and Engineer.

E. It shall be the responsibility of the Contractor to consult the Architect and Engineer Drawings and details so as to thoroughly familiarize himself with the

type and quality of construction to be provided on this project.

F. The Mechanical Drawings are diagrammatic in character and cannot show every connection in detail or every pipe and duct in its exact location. These details are subject to the requirements of codes, ordinances and electrical, plumbing, fire protection sprinkler piping, structural and architectural conditions. The Contractor shall carefully investigate all electrical, structural and finish conditions and shall coordinate the separate trades in order to avoid interference between the various phases of work. Work shall be laid out so that it will be concealed in furred chases or above suspended ceilings, etc., in finished portions of the building, unless specifically noted or indicated to be exposed. Work shall be installed to avoid crippling of structural members; therefore, inserts to accommodate hangers shall be set before concrete is poured, and proper openings through floor, walls, beams, etc., shall be provided as hereinafter specified or as otherwise indicated or required before concrete is poured. All work shall be run parallel or perpendicular to the lines of the building unless otherwise noted.

G. The approximate location of each item is indicated on the Drawings. These Drawings are not intended to give complete and exact details in regard to location. Exact locations are to be determined by actual measurements at the building and will in all cases be subject to the approval of the Architect. The Architect and Engineer reserves the right to make reasonable changes in the locations indicated without additional cost.

1.12 DELIVERY, STORAGE AND HANDLING

A. The Contractor shall not receive material or equipment at the job site until ready for installation or until there is suitable space provided to properly protect equipment from rust, weather, humidity, dust, or physical damage.

1.13 UTILITIES

A. The Contract Documents reflect the general location, size, and elevations of sewer line, location, size and pressure of water and other lines and manner of routing for all utilities known to be required on this project. It shall be the responsibility of the Contractor to visit the site, meet with the local utility companies in order to coordinate and confirm the exact requirements for each utility to provide a complete and operative system. The bid submitted by the Contractor shall include costs for all such coordinative work, as well as any and all utility company charges and/or fees.

1.14 TEMPORARY SERVICES

A. It shall be the responsibility of the Contractor to provide a temporary system for each utility that is required during construction with all such temporary utility costs being billed to the Contractor.

1.15 WARRANTIES AND GUARANTEE

A. The Contractor shall guarantee all materials and workmanship for a period of twelve (12) months after the final acceptance of work.

B. See applicable Division and Sections for WARRANTIES and additional requirements regarding warranties.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. The specifications contain the names of manufacturers, which are considered acceptable based on the quality of the product.

B. Where acceptable manufacturers are listed, only products of those manufacturers may be provided. Additionally, the product must meet all the detailed requirements of the specifications.

C. If no manufacturer's name is mentioned, the Contractor shall provide equipment and material which meet the specifications.

D. The Drawings represent the manufacturer's equipment scheduled. The listing of acceptable manufacturers in the specifications is not intended to imply that equipment of these other manufacturers will fit in the space provided or have the same electrical, structural or other requirements as the equipment scheduled. The Contractor must insure that the equipment provided will meet all project requirements prior to submitting data on that equipment.

2.2 MATERIALS AND EQUIPMENT

A. All materials shall be listed, inspected, and approved by the Underwriters Laboratories and shall bear the UL label where labeling service is available. The label or listing of the Underwriters Laboratories, Inc. will be accepted as evidence that the materials or equipment conform to the applicable standards of that agency. In lieu of this listing, the Contractor may submit a statement from a nationally recognized, adequately equipped testing agency, indicating that the items have been treated in accordance with required procedures, and that the materials and equipment comply with all contract requirements.

B. Materials and equipment shall be new and shall be the standard catalog products of manufacturers regularly engaged in the manufacture of products conforming to these Specifications, and shall essentially duplicate materials and equipment that have been in satisfactory use at least two years prior to bid opening. Where custom or special items are required, these shall be fully described using Drawings, material lists, etc., which fully describe in detail the item proposed for use on this project.

C. All metallic materials shall be protected against corrosion. Exposed metallic parts of outdoor apparatus made of ferrous metals but not of corrosion-resistant steel, shall be zinc-coated in accordance with ASTM A123 or A153, except where other equivalent protective treatment is specifically approved in writing.

D. Capacities shall be not less than those indicated but shall be such that no component or system becomes inoperative or is damaged because of start-up or other overload conditions. Where approved equipment requires electrical power other than those used for design purposes, the Contractor shall be responsible to adjust protective devices, starter sizes, conductors, conduits, etc. to accommodate this approved device electrically.

E. Each major component of equipment shall have the manufacturer's name, address, and catalog number on a plate securely attached to the item of equipment. All data on nameplates shall be legible at the time of final inspection.

F. Equipment vibration shall not exceed the following criteria:

Equipment	Maximum Allowable Vibration Peak to Peak Displacement (MIL)
Pumps	
1800 RPM	2
3600 RPM	1
Compressors	
Centrifugal	1
Screw	1
Fans (Centrifugal and Axial)	
Under 600 RPM	4
600 RPM to 1000 RPM	3
1000 RPM to 2000 RPM	2
Over 2000 RPM	1

G. All pipe, fittings, appurtenances, and other material required for complete installation of these systems shall be new to conform to manufacturer's recommendations, unless otherwise specified. All equipment injured or damaged in transit from factory, during delivery to premises, while in storage on premises, while being erected and installed, and while being tested, until time of final completion, shall be replaced by this Contractor without extra cost to the Owner. Scratched equipment shall be repainted with factory paint to match existing or cold galvanized as required.

H. Surface Burning Characteristics of Materials:
1. Unless specifically noted otherwise, all building and construction materials, adhesives, finishes, etc., shall have a composite assembly fire and smoke hazard rating as tested by Procedure ASTM E84, NFPA 255, and UL 723 not exceeding:
   a. Flame Spread: 25.

b. Smoke Developed: 50.
c. Fuel Contribution: 10.

NOTE: Any adhesives, mastics, and cement stored or used on the job site shall have the above fire and smoke hazard rating in the "wet state" in addition to its "dry" rating.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All equipment shall be installed in a manner to permit access to parts requiring service without disassembly of piping mains and other equipment. Access panels or doors shall be coordinated with the Architect and Engineer and provided where necessary to permit valve equipment service or removal. Refer to the architectural specifications for additional requirements.

B. Any large piece of apparatus which is to be installed in any space in the building, and which is too large to permit access through stairways, doorways, or shafts shall be brought to the job and placed in the space before the enclosing structure is completed. Following placement in the space, such apparatus shall be thoroughly and completely protected against damage.

C. This contract includes many different systems furnished and installed by different trades. Each trade shall coordinate their work with that of all other trades so that it may be installed in the most direct and workmanlike manner without hindering or handicapping any other trades. Where space requirements conflict, the following order of precedence shall, in general, be observed:
1. Building lines.
2. Structural members.
3. Soil and drain piping.
4. Vent piping.
5. Refrigerant piping.
6. Steam piping.
7. Condensate piping.
8. Electrical bus duct.
9. Supply ductwork.
10. Exhaust, return, and outside air ductwork.
11. Fire sprinkler piping.
12. Circulating water piping.
13. Domestic hot and cold water piping.
14. Natural gas piping.
15. Electrical conduit.

D. Minimize installation of water piping in proximity of rooms housing telephone equipment, fire alarm systems, transformers, or other electrical equipment. Do not install water piping within, or above ceilings of these rooms.

3.2 EXCAVATION AND BACKFILL

A. The Contractor shall perform all excavation of every description required in the

execution of his work. Excavation shall be through whatever substance encountered, to the depths indicated on the Drawings, or as required. Excavated material suitable for backfill shall be piled in an orderly manner a sufficient distance from the trench to prevent overloading sides and cave-ins. Excavated materials not suitable for backfill shall be removed from the site or stored as directed. Grading shall be done to protect the excavation from surface water. Trenches shall be maintained in a dry condition by bailing, pumping, or other approved methods. Pipe shall not be laid in wet trenches. Sheeting and shoring shall be provided as required for the protection of the work and the safety of personnel.

B. Trenches shall be of the necessary width and depth to provide for proper laying of pipe and appurtenances, with banks as nearly vertical as possible. Bottoms of trenches shall be excavated to the grade and depth indicated or required, and barrel of pipe shall be laid on a minimum 12 inch sand bed. Bell holes, of a size to permit proper make-up of grading, shall be provided as required. For projects located over the Edward's Aquifer Re-Charge Zone, comply with City of San Antonio Plumbing Code requirements. Existing underground piping shall be protected from damage during excavation and backfilling, and if damaged, shall be repaired to the Architect's and Engineer's satisfaction, at the Contractor's expense. Provide 3,000 pound concrete of 3 inch minimum enclosure around lines that cross electrical utility lines or telephone cables.

C. Trenches shall not be backfilled until all required tests have been performed. This requirement does not preclude sectional testing and backfilling of the various systems. Trenches shall be carefully backfilled with approved sand, free from large earth clods, rocks, and/or foreign materials, laid in 6 inch layers, moistened thoroughly, and carefully rammed to an elevation of one foot above top of pipe. The remainder of the backfill to finish grade shall be placed in one foot layers soaked with water, and well tamped. Under roadways, backfill to bottom of road bed material with sand only. Where settlement occurs, trenches shall be re-opened to depth required for proper compaction, refilled, and compacted.

D. Open trenches abutting foundation or basement excavations, building walls, and grade beams, will not be permitted, but shall be backfilled and completed, for a distance of not less than 10 feet from the above features, as soon as possible. All damage resulting from flooding or other stresses due to open trenches shall be paid for by the Contractor.

E. Where excavation requires, existing walks, street, drives, or other existing pavement to be cut to install new lines and to make new connections to existing lines, the size of the cut shall be held to a minimum, consistent with the work to be accomplished. After the installation of the new materials is completed and the excavation has been backfilled, the paving shall be patched, using materials to match those cut out. The patches shall be thoroughly bound with the original surfaces, and shall be level with them.

3.3 CUTTING AND PATCHING

A. Where it becomes necessary to cut through any wall, floor, or ceiling to permit installation of any work under this section of the Specifications or to repair any defects that may appear, up to the expiration of the guarantee period, such cutting shall be done under the supervision of the Architect and Engineer by the Contractor. The Contractor shall not be permitted to cut or modify any structural members without the written permission of the Architect and Engineer.

B. Patching of all openings cut by the Contractor, or repairing of any damage to the work of other trades occasioned by cutting operations, or occasioned by the failure of any part of work installed under this contract, shall be performed by the trade whose work is involved, but shall be paid for by the Contractor.

C. Any openings cut through exterior walls or roofs shall be provided with suitable covers, while they are left open, to protect the property or materials involved. Any openings cut through walls below grade shall be properly protected to prevent entrance of water or other damaging elements.

3.4 FIRE STOP SYSTEMS

A. Seal all pipe, conduit, cables, spare sleeves, etc. penetrations through roofs and fire-rated walls and floors with factory made devices or with manufactured fill, void, or cavity materials classified by Underwriters Laboratories (UL) as a "through-penetration fire stop" and which meet the following requirements:
   1. Maintain the fire resistance rating of the penetrated building construction. Refer to the architectural Contract Documents for fire ratings of general construction.
   2. Comply with the requirements of ASTM E814, UL 1979, ASTM E119, UL 723, ASTM E84 and UL 263 for all types of penetrations sealed.
   3. Do not exhibit excessive shrinkage, which would permit transmission of flame, smoke, gasses, vermin and/or water prior to exposure to a fire condition.
   4. Mastics used to seal surface of fire stop system shall be non-hardening.
   5. Shall accommodate expansion and contraction of the penetrating element, i.e. pipe etc., without reducing its effectiveness as a smoke barrier and/or water seal.

B. Submittal data for fire stop systems shall include applicable UL System numbers.

C. Installing Contractor shall submit evidence that he has been trained by an authorized fire stop system manufacturer's representative prior to beginning the installation. The manufacturer's representative shall visit the jobsite and visually observe representative samples of each of the various fire stop systems employed on this project, during and after installation, and provide a written certification that the installations observed appear to have been installed in accordance with the manufacturer's recommendations and UL requirements.

D. Sealing of conduits that extend through fire-rated walls from ends of cable tray shall be performed after conductors/cables have been installed.

E. Acceptable Manufacturer's Products: If it complies with these Specifications, one of the following manufacturers' fire stop sealing components/systems will be acceptable:
   1. 3M Fire Protection Products.
   2. General Electric and Specified Technologies, Inc. SpecSeal systems.
   3. Nelson Flameseal Fire Stop Putty (dry locations only).
   4. Specified Technologies, Inc.
   5. Tremco Fire Resistive Joint System utilizing "Dymeric" sealant and Cerablanket-FS mineral filler.

3.5 HOISTING, SCAFFOLDING, AND TRANSPORTATION

A. The Contractor shall provide his own hoisting facilities and scaffolding to set his materials and equipment in place, as indicated on Drawings and for subsequent cleaning, testing, and adjusting.

B. The Contractor shall provide necessary transportation to facilitate the delivery of all materials, equipment, tools, and labor to the job, in accordance with intent of these documents.

3.6 CLEANING

A. The Contractor shall, at all times, keep the premises free from accumulations of waste material or rubbish caused by him, his employees, or his work. This debris shall be removed, not only from the building, but also from the project site.

B. At completion of the job, the Contractor shall remove all of his tools, scaffolding, and surplus materials. He shall leave the area "broom clean".

3.7 ELECTRICAL WIRING OF MOTORS AND EQUIPMENT

A. Unless specifically shown, indicated, or specified to the contrary, each item shown or required by the Mechanical Drawings or specified in the Mechanical Specifications shall be accompanied by all motors and starting and controlling equipment necessary for the items proper operations. These motors shall be integrally attached to and/or installed with their associated equipment item and electrically connected as specified in Division 26 - Electrical. Equipment controlled from motor control centers shall be supplied with motors only. Motor control centers are specified in Division 26 and shown on the Electrical Drawings.

3.8 WORK IN EXISTING BUILDINGS

A. Some of the work to be performed on this project occurs within an existing occupied building. Noisy, dusty, fume emitting and/or other construction operations required for work which may disturb or cause complaints by the building occupants is unacceptable.

B. The Contractor and the Division 23 Subcontractor shall carefully examine the existing building and review all of the Contract Documents prior to submitting his bid in order to determine the extent of work required to be completed under

this Division. Failure to conduct this examination shall not relieve the Contractor of the responsibility to perform all the work required for a complete and fully operational installation satisfactory to the Owner.

C. Contractor shall include in the bid price cost of relocation or removal of existing equipment and systems required for complete installation of the new systems indicated in the Contract Documents. In submitting his bid, the Contractor agrees to accept all existing site conditions not specifically accepted. Where Contract Documents conflict with existing field conditions, a record of the field conditions shall be provided in writing to the Architect.

D. The Contractor shall be responsible for loss or damage to the existing facilities caused by him and his workmen, and shall be responsible for repairing or replacing such loss or damage. The Contractor shall send proper notices, make necessary arrangements, and perform other services required for the care, protection and service and in service maintenance of all plumbing, heating, air conditioning, and ventilating services for the new and existing facilities. The Contractor shall erect temporary barricades, with necessary safety devices, as required to protect personnel from injury, removing all such temporary protection upon completion of the work.

E. All new work shall be coordinated with existing space constraints. All equipment and material shall be fabricated such that complete systems may be disassembled into sections suitable for lifting in the existing freight elevator or construction hoist and fit through existing passageways without unauthorized modifications of the existing building construction.

F. The Contractor shall provide temporary on new services to all existing facilities as required to maintain their proper operation when normal services are disrupted as a result of the work being accomplished under this project.

G. Where existing construction is removed to provide working and extension access to existing utilities, Contractor shall remove doors, piping, conduit, outlet boxes, wiring, light fixtures, air conditioning ductwork and equipment, etc., to provide this access and shall reinstall same upon completion of work in the areas affected.

H. Coordinate new work in existing building in a manner that allows proper phasing of the work with a minimum of disruption of Owner's activities in occupied spaces. All work scheduled in occupied areas MUST BE COORDINATED WITH AND APPROVED BY THE OWNER prior to commencement of the work. Outages of services as required by the new installation will be permitted but only at a time approved by the Owner. The Contractor shall allow the Owner two weeks in order to schedule required outages. The time allowed for outages will not be during normal working hours unless otherwise approved by the Owner. All costs of outages, including overtime charges, shall be included in the contract amount.

I. The Contractor shall use construction methods and materials which shall not adversely affect the indoor air quality of the occupied areas. Contractor shall furnish and install temporary constructions and modify existing air handling system where required to isolate areas under construction from surrounding

occupied areas to control the migration of dust or fumes. If deemed necessary by the Owner, the Contractor shall furnish and install temporary supply and/or exhaust fan to negatively pressurize the construction area relative to adjacent occupied areas.

3.9 DEMOLITION AND RELOCATION

A. The Contractor shall modify, remove, and relocate all materials and items so indicated on the Drawings or required by the installation of new facilities. All removals and/or dismantling shall be conducted in a manner as to produce maximum salvage. Salvage materials except asbestos shall remain the property of the Owner, and shall be delivered to such destination as directed by the Owner. Non-salvageable materials and equipment shall become the property of the Contractor and removed from the site.

B. Asbestos abatement is being performed under a separate contract. There have been no tests for existence of asbestos or other potentially hazardous materials within this facility. The Contractor shall immediately notify the Owner of any area where the Contractor suspects or becomes aware of the existence of asbestos or other potentially hazardous materials on this project. It shall be the responsibility of the Contractor to provide written request to the Owner for the services of an Industrial Hygienist who shall provide all necessary testing, analysis and documentation of the status of any areas where asbestos or potentially hazardous materials exist. The Industrial Hygienist shall then prepare plans and specifications which provide for the removal of all potentially hazardous substances and their disposal in a lawful manner. The Contractor shall not remove or disturb asbestos or other potentially hazardous substances until he has obtained approval in writing of the methods he shall use from the authorities having jurisdiction.

C. All items which are to be relocated shall be carefully removed in reverse to original assembly or placement and protected until relocated. The Contractor shall clean and repair and provide all new materials, fittings, and appurtenances required to complete the relocation and to restore to good operative order. All relocations shall be performed by workmen skilled in the work and in accordance with standard practice of the trades involved. Where items scheduled for relocation and/or reuse are found to be in damaged condition before work has been started on dismantling, the Contractor shall call the attention of the Owner to such items and receive further instructions before removal. Items damaged in repositioning operations are the Contractor's responsibility and shall be repaired or replaced by the Contractor as approved by the Owner, at no additional cost to the Owner or the Architect and Engineer. The Contractor may, at his discretion, and upon the approval of the Owner, substitute new materials and items of like design and quality in lieu of materials and items to be relocated.

D. Service lines and wiring to items to be removed, salvaged, or relocated shall be removed to points acceptable to the Owner. Service lines and wiring not scheduled for reuse shall be removed to the points at which reuse is to be continued or service is to remain. Such services shall be sealed, capped, or otherwise tied-off or disconnected in a safe manner acceptable to the Owner.

E. Cleanup: It shall be the responsibility of each trade to cooperate fully with the other trades on the job to keep the jobsite in a clean and safe condition. At the end of each day's work, each trade shall properly store all of his tools, equipment and materials and shall clean his debris from the job.

3.10 COMMUNICATIONS AND ELECTRICAL EQUIPMENT ROOMS PRECAUTIONS

A. In general, piping and ductwork shall not be installed in any switchgear, transformer, elevator equipment, telephone, communication or electrical equipment room unless this piping or ductwork serves only that room.

B. Sprinkler heads and piping within main communication equipment rooms and rooms having electrical gear shall be provided with shields and/or deflectors where required by the AHJ or Owner to protect electrical and/or communications equipment.

C. Piping shall not be installed above switchboards, panelboards, control panels, motor control centers, individual motor controllers etc. Piping shall not be installed above bus duct unless otherwise show on the Drawings.

D. Coordinate with Division 26 Contractor to ensure the above listed precautions requirements are met.

PART 4 – REGULATORY REQUIREMENTS

4.1 RELATED SECTIONS

A. Section 01090 – REFERENCES.

4.2 AUTHORITY HAVING JURISDICTION

A. The "Authority Having Jurisdiction" (AHJ) over the project described by these documents is the Owner/State of Texas/the City of Kendall County.

B. Where alterations and/or deviations from the Contract Documents, i.e. Drawings and Specifications, are required by the AHJ, report the requirements to the Architect and secure his written approval before starting the alteration.

C. Modifications to the Division 23 work required by the AHJ shall be made by the Contractor without additional cost to the Owner.

4.3 CODES AND REFERENCE STANDARDS

A. All materials and workmanship shall comply with the requirements of the Building, Mechanical, Electrical, Plumbing, Fire, Accessibility, and Energy Codes adopted by the City of San Antonio, including all amendments, applicable laws and ordinances and supplementary rules and interpretations. Where Contract Document requirements exceed Code requirements and are permitted under the Code, the Contract Documents shall govern.

B. In all cases where Underwriter's Laboratories, Inc. have established standards for a particular type material, such material shall comply with these standards or other nationally recognized testing standards acceptable to the Authority Having Jurisdiction. Evidence of compliance shall be the UL "label" or "listing" under Re-Examination Service.

C. The following specific codes and standards shall apply to this project:
1. ADA Accessibility Guidelines for Buildings and Facilities, 1991 (ADAAG) with current amendments.
2. Americans with Disabilities Act, Part III, 28 CFR 36, July 26, 1991 (ADA).
3. Building Services Piping (ASME/ANSI B31.9).
4. Elimination of Architectural Barriers Act, Texas Department of Licensing and Regulations, Texas Civil Statutes, Article 9102,
5. Energy Conservation Standard for New State Buildings.
6. Governing Fire Department requirements.
7. National Fire Codes (NFPA), current edition.
8. National Electrical Code (NFPA 70), latest edition.
9. Occupational Safety and Health Act (OSHA).
10. Texas Accessibility Standards (TAS), Texas Department of Licensing and Regulations (TDLR), Architectural Barriers Act, Article 9102, Texas Civil Statutes, effective April 1, 1994.
11. Texas Boiler Law, Chapter 755, Health and Safety Code, Texas Department of Licensing and Regulations.
12. Current applicable 2018 International Building code with local amendments.
13. Current applicable 2018 International Mechanical code with local amendments.
14. Current applicable 2018 International Fire code with local amendments.
15. Current applicable 2018 International Energy conservation code with local amendments.
16. Current applicable 2018 International Plumbing code with local amendments.
17. Current applicable 2018 National Electric code with local amendments.
18. Current applicable 2001 Supplemental with local amendments.

D. Refer to Division 01 and the Division 23 Specification Sections hereinafter bound for additional applicable regulatory requirements.

4.4 OWNER'S RULES AND REGULATIONS

A. Comply with Owner's rules and regulations as they apply.

4.5 DISCREPANCIES

A. The Contract Documents are intended to comply with the aforementioned rules and regulations; however, some discrepancies may occur. Where such discrepancies occur, the Contractor shall immediately notify the Architect and Engineer in writing of said discrepancies and apply for an interpretation.

B. Should the discovery and notification occur after the execution of the Contract, any additional work required for compliance with said regulations shall be paid for as covered by Division 1, providing no work or fabrication of

materials has been accomplished in a manner of noncompliance.

C. Should the Contractor fabricate and/or install materials and/or workmanship in such a manner that does not comply with the applicable codes, rules and regulations, the Contractor who performed such work shall bear all costs arising in correcting these deficiencies to comply with said rules and regulations.

END OF SECTION 230510

SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

B. Motors: Furnished and installed under Division 23, connected under Division 26.

C. Controllers:

ITEM	DIVISION OF WORK		
	SPECIFIED	FURNISHED	INSTALLED
Controllers in motor control centers	26	26	26
Controllers not located in motor control centers	26	23	26
Variable Frequency Drives	26	23	26

1.3 COORDINATION

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

1.4 SUBMITTALS

A. Comply with applicable Divisions and Sections "Shop Drawings, Product Data and Samples" and requirements indicated in the applicable sections of this Division.

B. Submit certification that equipment complies with IEEE Standard 519.

1.5 REFERENCE STANDARDS AND QUALITY ASSURANCE

A. NFPA – 70 – 1996, National Electrical Code.

B. NEMA MG1-1993, Motors and Generators.

C. NEMA MG10-1994, Energy Management Guide for Selection and Use of Polyphase Motors.

D. UL 674-1994, Electric Motors, and Generators for use in Division 01 Hazardous (Classified) Locations.

E. UL 1004-1994, Electric Motors.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Motors and Controllers
1. ABB.
2. Baldor.
3. General Electric.
4. Reliance.
5. Square D.

2.2 MOTORS

A. For alternating current, fractional and integral horsepower motors, NEMA Publication MG1 and MG2 shall apply. NEMA MG10 shall apply for energy management selection of polyphase motors. Any motor controlled by a variable frequency drive shall meet the requirements of NEMA MG1, Part 31.40.4.2 to accommodate voltage spikes from IGBT switching transients without damaging the motor windings or other major components.

B. Voltage ratings shall be as follows:
1. Single phase:
a. Motors connected to 120 volt systems: 115 volts.
b. Motors connected to 208 volt systems: 200 volts.
c. Motors connected to 240 volt systems: 230/460 volts, dual connection.
2. Three phase:
a. Motors connected to 208 volt systems: 200 volts.
b. Motors, less than 100 HP, connected to 240 volt or 480 volt systems: 230/460 volts, dual connection.
c. Motors, 100 HP or larger, connected to 240 volt systems: 230 volts.
d. Motors, 100 HP or larger, connected to 480 volt systems: 460 volts.

C. Number of phases shall be as follows:
1. Motors, less than 3/4 HP: Single phase.
2. Motors, 3/4 HP and larger: Three (3) phase.
3. Exceptions:
a. Hermetically sealed motors.
b. Motors for equipment assemblies, 3/4 HP and larger, may be single phase provided the manufacturer of the proposed assemblies cannot supply assemblies with three phase motors and the cost for

electrical circuiting changes required to accommodate the single phase motor are paid for by the Division 23 Contractor at no additional expense to the Owner.

D. Horsepower ratings shall be adequate for operating the connected loads continuously in the prevailing ambient temperatures in areas where the motors are installed, without exceeding the NEMA Standard temperature rises for the motor insulation.

E. Motor designs, as indicated by the NEMA code letters, shall be coordinated with the connected loads to assure adequate starting and running torque.

F. Bearings:
1. Motors shall be equipped with pre-lubricated steel ball or roller bearings.
2. Bearings shall have rated fatigue life of 20,000 hours (L-10 minimum) assuming bearing load calculated with minimum NEMA pulley size so located that centerline of belt load is at ten end of the NEMA standard shaft extension (worst condition).
3. Bearings housings shall be equipped with grease openings for simultaneously adding new grease and purging the old grease. Provide corrosion resistant plugs or caps on grease openings, which are easily accessible.
4. Rotating shaft seals or slingers at both fan and shaft ends shall be provided to prevent entry of contaminants and prevent grease leakage.
5. Bearings in motors controlled by variable frequency drives shall be guaranteed against premature bearing failure caused by discharge current. All motors controlled by variable frequency drives shall be provided with internal shaft grounding device.

G. Motor insulation shall be NEMA Design B for standard duty motors. Severe duty motors shall have Class F insulation. Temperature rise will be in accordance with NEMA limits for class of insulation, service factor, and enclosure specified. Unless otherwise noted, motors shall be rated for 40 degrees C ambient temperature. Motors scheduled for use with a variable frequency drive shall have spike resistant windings and shall be rated for inverter duty.

H. Motor enclosures shall be open drip-proof construction, except where exposed to weather where they shall be splash-proof with rodent screens. Where adverse vapors or dust conditions prevail, enclosures shall be totally-enclosed, or totally-enclosed fan-cooled. In explosive atmospheres, explosion-proof fan-cooled enclosures with non-spark fans shall be provided. Motor frames shall be of heavy-duty construction using steel, aluminum or cast iron. End brackets shall be of cast iron or aluminum construction. Aluminum must have steel inserts in bearing cavity. Severe duty motors shall be cast iron construction (frame, end brackets and terminal box) and have external hardware including fan and fan cover plated to prevent corrosion or be of corrosion resistant material. The air gap surfaces shall be coated with epoxy or zinc chromate to resist corrosion.

I. Polyphase motors shall be EPACT 1992 compliant squirrel cage design with NEMA Design B or NEMA Design E locked-rotor, break-down and pull-out torque as standard unless otherwise specified. For heavy inertia loads, provide motors

having design torque characteristics. Motors shall have minimum service factor of 1.15.

J. Motor loading under normal conditions shall not exceed motor nameplate loads, at applied temperature. Motors shall not be selected to operate within the service factor range of motor.

K. Motor enclosures shall be thoroughly cleaned and painted at the factory with the manufacturer's prime coat and standard finish. Special painting shall be as specified.

L. Motor speeds shall be nominally 1800 RPM when applied to 60 Hz system.

M. Belts, chains, pulleys, couplings, motor shafts, gears and other moving parts shall be enclosed and guarded. The guards shall be metal, not less than No. 14 gage, and removable for servicing of the motors without disassembling pipes or fittings.

N. Energy Efficiency:
1. Motors will have a power factor rating at full load and rated voltage of at least 90 percent. If a motor draws less than 1000 watts at full load, it is excluded from the 90 percent P.F. requirement.
2. The minimum full load efficiency (P.F. x Eff.) shall meet or exceed values below:

MOTOR HORSEPOWER	NOMINAL FULL-LOAD EFFICIENCY					
	OPEN MOTORS			ENCLOSED MOTORS		
	6 POLE	4 POLE	2 POLE	6 POLE	4 POLE	2 POLE
1	80.0	82.5		8.0	82.5	75.5
1.5	84.0	84.0	82.5	85.5	84.0	82.5
2	85.5	94.0	84.0	86.5	84.0	84.0
3	86.5	86.5	84.0	87.5	87.5	85.5
5	97.5	87.5	85.5	87.5	87.5	87.5
7.5	88.5	88.5	87.5	89.5	89.5	88.5
10	90.2	89.5	88.5	89.5	89.5	89.5
15	90.2	91.0	89.5	90.2	91.0	90.2
20	91.0	91.0	90.2	90.2	91.0	90.2
25	91.7	91.7	91.0	91.7	92.4	91.0
30	92.4	92.4	91.0	91.7	92.4	91.0
40	93.0	93.0	91.7	93.0	93.0	91.7
50	93.0	93.0	92.4	93.0	93.0	92.4
60	93.6	93.6	93.0	93.6	93.6	93.0
75	93.6	94.1	93.0	93.6	94.1	93.0
100	94.1	94.1	93.0	94.1	94.5	93.6
125	94.1	94.5	93.6	94.1	94.5	94.5
150	94.5	95.0	93.6	95.0	95.0	94.5

MOTOR HORSEPOWER	NOMINAL FULL-LOAD EFFICIENCY					
	OPEN MOTORS			ENCLOSED MOTORS		
	6 POLE	4 POLE	2 POLE	6 POLE	4 POLE	2 POLE
200	94.5	95.0	94.5	95.0	95.0	95.0

O. Additional requirements for specific motors, as indicated in other sections, shall also apply.

2.3 GENERAL MOTOR REQUIREMENTS

A. Comply with NEMA MG 1 unless otherwise indicated.

B. Comply with IEEE 841 for severe-duty motors.

2.4 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 104 deg F (40 deg C) and at altitude of 3300 feet (1000 m) above sea level.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.5 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Energy efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Multispeed Motors: Variable torque.
1. For motors with 2:1 speed ratio, consequent pole, single winding.
2. For motors with other than 2:1 speed ratio, separate winding for each speed.

E. Multispeed Motors: Separate winding for each speed.

F. Rotor: Random-wound, squirrel cage.

G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

H. Temperature Rise: Match insulation rating.

I. Insulation: Class F.

J. Code Letter Designation:
1. Motors 15 HP and Larger: NEMA starting Code F or Code G.

2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.

K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.6 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

C. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.7 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
1. Permanent-split capacitor.
2. Split phase.
3. Capacitor start, inductor run.
4. Capacitor start, capacitor run.

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

C. Bearings: Pre-lubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type.

E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION

3.1 MOTOR INSTALLATION

A. Install loose motor on base.

B. Install pulleys and belts.

C. Adjust belt tension.

D. Install necessary internal wiring.

E. Adjust speed on driven device to obtain prescribed capacity.

F. Check motor load electrically to determine the motor is not overloaded when the driven device is operating at prescribed capacity.

END OF SECTION 230513

SECTION 230517 - SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Sleeves.
2. 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/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.

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

D. Galvanized-Steel-Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

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

2.2 STACK-SLEEVE FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following :
1. Smith, Jay R. Mfg. Co.
2. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.

B. 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: Carbon steel or Stainless steel.
   3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, or Stainless steel of length required to secure pressure plates to sealing elements.

2.4 SLEEVE-SEAL FITTINGS

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

B. 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 (34.5-MPa), 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 (25-mm) annular clear space between piping and concrete slabs and walls.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
   1. Cut sleeves to length for mounting flush with both surfaces.
      a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 3 inches (50 mm) above finished floor level.
   2. 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 (6.4-mm) 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-inch (6.4-mm) 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 3 inches (50 mm) 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 (DN 150): Galvanized-steel-pipe sleeves or Sleeve-seal fittings.
   b. Piping NPS 6 (DN 150) and Larger: Galvanized-steel wall sleeves or Galvanized-steel-pipe sleeves.
2. Exterior Concrete Walls below Grade:
   a. Piping Smaller Than NPS 6 (DN 150): Cast-iron wall sleeves with sleeve-seal system or Galvanized-steel wall sleeves with sleeve-seal system.
      1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.
   b. Piping NPS 6 (DN 150) and Larger: Cast-iron wall sleeves with sleeve-seal system or Galvanized-steel-pipe sleeves with sleeve-seal system.
      1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.
3. Concrete Slabs-on-Grade:
   a. Piping Smaller Than NPS 6 (DN 150): Galvanized-steel wall sleeves with sleeve-seal system or Galvanized-steel-pipe sleeves with sleeve-seal system.
      1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.
   b. Piping NPS 6 (DN 150) and Larger: Galvanized-steel-pipe sleeves with sleeve-seal system.
      1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.
4. Concrete Slabs above Grade:
   a. Piping Smaller Than NPS 6 (DN 150): Stack-sleeve fittings or Sleeve-seal fittings.

b. Piping NPS 6 (DN 150) and Larger: Galvanized-steel-pipe sleeves or Stack-sleeve fittings.

5. Interior Partitions:
   a. Piping Smaller Than NPS 6 (DN 150): Galvanized-steel-pipe sleeves.
   b. Piping NPS 6 (DN 150) and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION 230517

SECTION 230518 - ESCUTCHEONS FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Escutcheons.
2. Floor plates.

1.3 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.

D. Split-Casting Brass Type: With polished, chrome-plated finish and with concealed hinge and setscrew.

E. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed hinge, and spring-clip fasteners.

2.2 FLOOR PLATES

A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

B. Split-Casting Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

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

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
   1. Escutcheons for New Piping:
      a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
      b. Chrome-Plated Piping: One-piece, cast-brass type with polished, chrome-plated finish.
      c. Insulated Piping: One-piece, stamped steel.
      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 Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
      f. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type or one-piece, cast-brass type with rough-brass finish or split-casting brass type with concealed hinge.
      g. Bare Piping in Equipment Rooms: One-piece, stamped-steel type or one-piece, cast-brass type with rough-brass finish or split-casting brass type with concealed hinge.
   2. Escutcheons for Existing Piping:
      a. Chrome-Plated Piping: Split-casting brass type with polished, chrome-plated finish.
      b. Insulated Piping: Split-plate, stamped-steel type with concealed hinge.
      c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting brass type with concealed hinge.
      d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed or exposed-rivet hinge.
      e. Bare Piping in Unfinished Service Spaces: Split-plate, stamped-steel type with concealed hinge.
      f. Bare Piping in Equipment Rooms: Split-casting brass type with polished, chrome-plated finish.

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

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
   1. New Piping: One-piece, floor-plate type.
   2. Existing Piping: Split-casting, floor-plate type.

3.2 FIELD QUALITY CONTROL

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

END OF SECTION 230518

SECTION 230529 - HANGERS AND SUPPORTS for HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Inserts and Rods
2. Flashing for Mechanical Piping and Equipment
3. Metal pipe hangers and supports.
4. Trapeze pipe hangers.
5. Metal framing systems.
6. Thermal-hanger shield inserts.
7. Fastener systems.
8. Pipe stands.
9. Equipment supports.

B. Related Sections:
1. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Section 233113 "Metal Ducts" for duct hangers and supports.

1.3 DEFINITIONS

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

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

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

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

1.5 SUBMITTALS

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

B. Refer to Section 230500 "Common Work Results for HVAC".

C. Shop Drawings: Show fabrication and installation details and include calculations for the following: include Product Data for components:
   1. Wall Supports
   2. Hangers and Hanger Attachments
   3. Details of Pipe Penetrations
   4. Sleeves
   5. Sealing and UL Approved Fire Stop Assemblies
   6. Floor Supports
   7. Trapeze pipe hangers.
   8. Metal framing systems.
   9. Pipe stands.
   10. Equipment supports.

D. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   1. Detailed fabrication and assembly of trapeze hangers.
   2. Design Calculations: Calculate requirements for designing trapeze hangers.

1.6 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.7 QUALITY ASSURANCE

A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 INSERTS AND RODS

A. Use inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams wherever practicable.

B. Use drilled expansion anchors in existing concrete structures.

C. Where concrete slabs form finished ceiling, finish inserts, flush with slab surface.

D. Where inserts are omitted, drill through concrete slab from below and provide rod with recessed square steel plate and nut above slab.

E. Provide tunnel support system to General Contractor for insertion into form work prior to concrete placement.

F. Provide electro-galvanized steel hanger rods, threaded both ends, threaded one end or continuous threaded.

G. Size inserts to suit threaded hanger rods.

2.2 FLASHING

A. Steel Flashing: 26-gauge galvanized steel.

B. Lead Flashing: five (5) lb./sq.ft. sheet lead for waterproofing, one (1) lb./sq.ft. sheet lead to soundproofing.

C. Safes: five (5) lb./sq.ft. sheet lead or eight (8) mil thick neoprene.

D. Caps: Steel, 22-gauge minimum, 16 gauge at fire resistant structures.

2.3 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:
1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pre-galvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

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

2.4 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.

2.5 METAL FRAMING SYSTEMS

A. Non-MFMA Manufacturer Metal Framing Systems:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product 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; H-Strut Division.
   e. NIBCO INC.
   f. PHD Manufacturing, Inc.
   g. PHS Industries, Inc.
3. Description: Shop- or field-fabricated pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
4. Standard: Comply with MFMA-4.
5. Channels: Continuous slotted steel channel with inturned lips.

6. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
7. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
8. Coating: Zinc.

2.6 THERMAL-HANGER SHIELD INSERTS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Carpenter & Paterson, Inc.
2. Clement Support Services.
3. ERICO International Corporation.
4. National Pipe Hanger Corporation.
5. PHS Industries, Inc.
6. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
7. Piping Technology & Products, Inc.
8. Rilco Manufacturing Co., Inc.
9. Value Engineered Products, Inc.

B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig (688-kPa) minimum compressive strength and vapor barrier.

C. Insulation-Insert Material for Hot Piping: ASTM C 552, Type II cellular glass with 100-psig (688-kPa) or minimum compressive strength.

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

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

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

2.7 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.8 PIPE STANDS

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

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

C. Low-Type, Single-Pipe Stand: One-piece stainless-steel base unit with plastic roller.

D. High-Type, Single-Pipe Stand:

1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
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:
1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
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.

2.9 EQUIPMENT SUPPORTS

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

2.10 MISCELLANEOUS MATERIALS

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

B. Refer to Section 230500 "Common Work Results for HVAC".

C. 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 (34.5-MPa), 28-day compressive strength.
3. Refer to section 230500 "Common Work Results for HVAC".

PART 3 - EXECUTION

3.1 INSERTS

A. Use inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams wherever practicable.

B. Set inserts in position in advance of concrete work. Provide reinforcement rod in concrete for inserts carrying pipe over four (4) inches or ducts over 60 inches wide.

C. Where concrete slabs form finished ceiling, finish inserts, flush with slab surface.

3.2 FLASHING

A. Flash and counter flash where mechanical equipment passes through weather or waterproofed walls, floor, and roofs.

B. Flash vent and soil pipes projecting 12 inches minimum above finished roof surface with lead worked one (1) inch minimum into hub, eight (8) inch minimum clear on sides with

minimum 24 inch x 24 inch sheet size. For pipes through outside walls, turn flange back into wall and caulk.

C. Flash floor drains over finished areas with lead 10 inch clear on sides with minimum 36 inch x 36 inch sheet size. Fasten flashing to drain clamp device.

D. Provide curbs for mechanical roof installation 12-inch minimum high. Flash and counter flash with steel, soldered and waterproofed.

3.3 HANGER AND SUPPORT INSTALLATION

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

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
   1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
   2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Metal framing system in first paragraph below requires calculating and detailing at each use.

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 (100 mm) thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturers. Install fasteners according to powder-actuated tool manufacturer's operating manual.
   2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to the manufacturer's written instructions.

G. Pipe Stand Installation:
   1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount them on smooth roof surface. Do not penetrate roof membrane.
   2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 077200 "Roof Accessories" for curbs.

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

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

J. 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.

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

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

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

N. 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.

O. 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.
   3. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.
   4. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
      a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.
   5. Shield Dimensions for Pipe: Not less than the following:
      a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
      b. NPS 4 (DN 100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.
      c. NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.
      d. NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches (610 mm) long and 0.075 inch (1.91 mm) thick.
      e. NPS 16 to NPS 24 (DN 400 to DN 600): 24 inches (610 mm) long and 0.105 inch (2.67 mm) thick.
   6. Pipes NPS 8 (DN 200) and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
   7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.4 EQUIPMENT SUPPORTS

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

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

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

3.5 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 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 undercutting 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.

3.6 ADJUSTING

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

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

3.7 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
   1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils (0.05 mm).

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

C. Paint all supports to prevent corrosion (Typical).

3.8 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, metal trapeze pipe hangers and metal framing systems and attachments for general service applications.

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

G. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.

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

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

J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
   2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F (566 deg C), pipes NPS 4 to NPS 24 (DN 100 to DN 600), requiring up to 4 inches (100 mm) of insulation.
   3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36 (DN 20 to DN 900), requiring clamp flexibility and up to 4 inches (100 mm) of insulation.
   4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 (DN 15 to DN 600) if little or no insulation is required.
   5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4 (DN 15 to DN 100), to allow off-center closure for hanger installation before pipe erection.
   6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8 (DN 20 to DN 200).
   7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
   8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
   9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
   10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8 (DN 10 to DN 200).
   11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3 (DN 10 to DN 80).
   12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
   13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
   14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
   15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
   16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 (DN 65 to DN 900) if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.

17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30 (DN 25 to DN 750), from two rods if longitudinal movement caused by expansion and contraction might occur.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24 (DN 65 to DN 600), from single rod if horizontal movement caused by expansion and contraction might occur.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 (DN 50 to DN 1050) if longitudinal movement caused by expansion and contraction 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 (DN 50 to DN 600) 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 (DN 50 to DN 750) if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24 (DN 24 to DN 600).
   2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 (DN 20 to DN 600) if longer ends are required for riser clamps.

L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches (150 mm) for heavy loads.
   2. Steel Clevises (MSS Type 14): For 120 to 450 deg F (49 to 232 deg C) piping installations.
   3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
   4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
   5. Steel Weld less Eye Nuts (MSS Type 17): For 120 to 450 deg F (49 to 232 deg C) piping installations.

M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
   2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
   3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
   4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
   5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
   6. C-Clamps (MSS Type 23): For structural shapes.
   7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
   8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
   9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.

10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
    a. Light (MSS Type 31): 750 lb (340 kg).
    b. Medium (MSS Type 32): 1500 lb (680 kg).
    c. Heavy (MSS Type 33): 3000 lb (1360 kg).
13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
    1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
    2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
    3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
    1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
    2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches (32 mm).
    3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
    4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
    5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
    6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
    7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
    8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
        a. Horizontal (MSS Type 54): Mounted horizontally.
        b. Vertical (MSS Type 55): Mounted vertically.
        c. Trapeze (MSS Type 56): Two vertical type supports and one trapeze member.

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

Q. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

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

END OF SECTION 230529

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. Inserts and Rods
2. Flashing for Mechanical Piping and Equipment
3. Metal pipe hangers and supports.
4. Trapeze pipe hangers.
5. Metal framing systems.
6. Thermal-hanger shield inserts.
7. Fastener systems.
8. Pipe stands.
9. Equipment supports.

B. Related Sections:
1. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Section 233113 "Metal Ducts" for duct hangers and supports.

1.3 DEFINITIONS

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

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

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

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

1.5 SUBMITTALS

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

B. Refer to Section 230500 "Common Work Results for HVAC".

C. Shop Drawings: Show fabrication and installation details and include calculations for the following: include Product Data for components:
   1. Wall Supports
   2. Hangers and Hanger Attachments
   3. Details of Pipe Penetrations
   4. Sleeves
   5. Sealing and UL Approved Fire Stop Assemblies
   6. Floor Supports
   7. Trapeze pipe hangers.
   8. Metal framing systems.
   9. Pipe stands.
   10. Equipment supports.

D. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   1. Detailed fabrication and assembly of trapeze hangers.
   2. Design Calculations: Calculate requirements for designing trapeze hangers.

1.6 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.7 QUALITY ASSURANCE

A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 INSERTS AND RODS

A. Use inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams wherever practicable.

B. Use drilled expansion anchors in existing concrete structures.

C. Where concrete slabs form finished ceiling, finish inserts, flush with slab surface.

D. Where inserts are omitted, drill through concrete slab from below and provide rod with recessed square steel plate and nut above slab.

E. Provide tunnel support system to General Contractor for insertion into form work prior to concrete placement.

F. Provide electro-galvanized steel hanger rods, threaded both ends, threaded one end or continuous threaded.

G. Size inserts to suit threaded hanger rods.

2.2 FLASHING

A. Steel Flashing: 26-gauge galvanized steel.

B. Lead Flashing: five (5) lb./sq.ft. sheet lead for waterproofing, one (1) lb./sq.ft. sheet lead to soundproofing.

C. Safes: five (5) lb./sq.ft. sheet lead or eight (8) mil thick neoprene.

D. Caps: Steel, 22-gauge minimum, 16 gauge at fire resistant structures.

2.3 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:
1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pre-galvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

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

2.4 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.

2.5 METAL FRAMING SYSTEMS

A. Non-MFMA Manufacturer Metal Framing Systems:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product 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; H-Strut Division.
   e. NIBCO INC.
   f. PHD Manufacturing, Inc.
   g. PHS Industries, Inc.
3. Description: Shop- or field-fabricated pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
4. Standard: Comply with MFMA-4.
5. Channels: Continuous slotted steel channel with inturned lips.

6. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
7. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
8. Coating: Zinc.

2.6 THERMAL-HANGER SHIELD INSERTS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Carpenter & Paterson, Inc.
2. Clement Support Services.
3. ERICO International Corporation.
4. National Pipe Hanger Corporation.
5. PHS Industries, Inc.
6. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
7. Piping Technology & Products, Inc.
8. Rilco Manufacturing Co., Inc.
9. Value Engineered Products, Inc.

B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig (688-kPa) minimum compressive strength and vapor barrier.

C. Insulation-Insert Material for Hot Piping: ASTM C 552, Type II cellular glass with 100-psig (688-kPa) or minimum compressive strength.

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

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

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

2.7 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.8 PIPE STANDS

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

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

C. Low-Type, Single-Pipe Stand: One-piece stainless-steel base unit with plastic roller.

D. High-Type, Single-Pipe Stand:

1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
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:
1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
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.

2.9 EQUIPMENT SUPPORTS

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

2.10 MISCELLANEOUS MATERIALS

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

B. Refer to Section 230500 "Common Work Results for HVAC".

C. 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 (34.5-MPa), 28-day compressive strength.
3. Refer to section 230500 "Common Work Results for HVAC".

PART 3 - EXECUTION

3.1 INSERTS

A. Use inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams wherever practicable.

B. Set inserts in position in advance of concrete work. Provide reinforcement rod in concrete for inserts carrying pipe over four (4) inches or ducts over 60 inches wide.

C. Where concrete slabs form finished ceiling, finish inserts, flush with slab surface.

3.2 FLASHING

A. Flash and counter flash where mechanical equipment passes through weather or waterproofed walls, floor, and roofs.

B. Flash vent and soil pipes projecting 12 inches minimum above finished roof surface with lead worked one (1) inch minimum into hub, eight (8) inch minimum clear on sides with

minimum 24 inch x 24 inch sheet size. For pipes through outside walls, turn flange back into wall and caulk.

C. Flash floor drains over finished areas with lead 10 inch clear on sides with minimum 36 inch x 36 inch sheet size. Fasten flashing to drain clamp device.

D. Provide curbs for mechanical roof installation 12-inch minimum high. Flash and counter flash with steel, soldered and waterproofed.

3.3 HANGER AND SUPPORT INSTALLATION

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

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
   1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
   2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Metal framing system in first paragraph below requires calculating and detailing at each use.

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 (100 mm) thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturers. Install fasteners according to powder-actuated tool manufacturer's operating manual.
   2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to the manufacturer's written instructions.

G. Pipe Stand Installation:
   1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount them on smooth roof surface. Do not penetrate roof membrane.
   2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 077200 "Roof Accessories" for curbs.

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

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

J. 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.

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

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

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

N. 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.

O. 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.
   3. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.
   4. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
      a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.
   5. Shield Dimensions for Pipe: Not less than the following:
      a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
      b. NPS 4 (DN 100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.
      c. NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.
      d. NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches (610 mm) long and 0.075 inch (1.91 mm) thick.
      e. NPS 16 to NPS 24 (DN 400 to DN 600): 24 inches (610 mm) long and 0.105 inch (2.67 mm) thick.
   6. Pipes NPS 8 (DN 200) and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
   7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.4 EQUIPMENT SUPPORTS

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

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

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

3.5 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 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 undercutting 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.

3.6 ADJUSTING

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

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

3.7 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
   1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils (0.05 mm).

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

C. Paint all supports to prevent corrosion (Typical).

3.8 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, metal trapeze pipe hangers and metal framing systems and attachments for general service applications.

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

G. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.

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

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

J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
   2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F (566 deg C), pipes NPS 4 to NPS 24 (DN 100 to DN 600), requiring up to 4 inches (100 mm) of insulation.
   3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36 (DN 20 to DN 900), requiring clamp flexibility and up to 4 inches (100 mm) of insulation.
   4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 (DN 15 to DN 600) if little or no insulation is required.
   5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4 (DN 15 to DN 100), to allow off-center closure for hanger installation before pipe erection.
   6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8 (DN 20 to DN 200).
   7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
   8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
   9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
   10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8 (DN 10 to DN 200).
   11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3 (DN 10 to DN 80).
   12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
   13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
   14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
   15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
   16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 (DN 65 to DN 900) if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.

17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30 (DN 25 to DN 750), from two rods if longitudinal movement caused by expansion and contraction might occur.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24 (DN 65 to DN 600), from single rod if horizontal movement caused by expansion and contraction might occur.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 (DN 50 to DN 1050) if longitudinal movement caused by expansion and contraction 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 (DN 50 to DN 600) 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 (DN 50 to DN 750) if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24 (DN 24 to DN 600).
   2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 (DN 20 to DN 600) if longer ends are required for riser clamps.

L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches (150 mm) for heavy loads.
   2. Steel Clevises (MSS Type 14): For 120 to 450 deg F (49 to 232 deg C) piping installations.
   3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
   4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
   5. Steel Weld less Eye Nuts (MSS Type 17): For 120 to 450 deg F (49 to 232 deg C) piping installations.

M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
   2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
   3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
   4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
   5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
   6. C-Clamps (MSS Type 23): For structural shapes.
   7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
   8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
   9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.

10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
    a. Light (MSS Type 31): 750 lb (340 kg).
    b. Medium (MSS Type 32): 1500 lb (680 kg).
    c. Heavy (MSS Type 33): 3000 lb (1360 kg).
13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
    1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
    2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
    3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
    1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
    2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches (32 mm).
    3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
    4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
    5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
    6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
    7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
    8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
        a. Horizontal (MSS Type 54): Mounted horizontally.
        b. Vertical (MSS Type 55): Mounted vertically.
        c. Trapeze (MSS Type 56): Two vertical type supports and one trapeze member.

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

Q. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

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

END OF SECTION 230529

SECTION 230548 - VIBRATION CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
1. Isolation pads.
2. Isolation mounts.
3. Restrained elastomeric isolation mounts.
4. Housed spring mounts.
5. Elastomeric hangers.
6. Spring hangers.
7. Spring hangers with vertical-limit stops.
8. Pipe riser resilient supports.
9. Resilient pipe guides.
10. Restraining braces and cables.

1.3 DEFINITIONS

A. IBC: International Building Code.

B. ICC-ES: ICC-Evaluation Service.

C. OSHPD: Office of Statewide Health Planning and Development for the State of California.

1.4 PERFORMANCE REQUIREMENTS

A. Wind-Restraint Loading:
1. Basic Wind Speed: 120 MPH.
2. Minimum 10 lb/sq. ft. multiplied by the maximum area of the HVAC component projected on a vertical plane that is normal to the wind direction, and 45 degrees either side of normal.

1.5 SUBMITTALS

A. Product Data: For the following:
1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
2. 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.

B. 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.

C. Welding certificates.

D. Qualification Data: For professional engineer and testing agency.

E. Air-Mounting System Performance Certification: Include natural frequency, load, and damping test

data performed by an independent agency.

F. Operation and Maintenance Data: For air-mounting systems to include in operation and maintenance manuals.

1.6 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."

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

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. Ace Mountings Co., Inc.
2. Amber/Booth Company, Inc.
3. B-Line Systems, Inc.
4. Isolation Technology, Inc.
5. Kinetics Noise Control.
6. Mason Industries.
7. Vibration Eliminator Co., Inc.
8. Vibration Isolation.
9. Vibration Mountings & Controls, Inc.

C. Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
1. Resilient Material: Oil- and water-resistant neoprene rubber.

D. Mounts: Double-deflection type, with molded, oil-resistant rubber, hermetically sealed compressed fiberglass, or neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Color-code or otherwise identify to indicate capacity range.
1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.

E. Spring Isolators: Freestanding, laterally stable, open-spring isolators.
1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.

4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4- inch-thick, rubber isolator pad attached to base plate underside. Base plates shall limit floor load to 500 psig.
6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

F. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with 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.
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 Spring Mounts: Housed spring isolator with integral seismic snubbers.
1. Housing: Ductile-iron or steel housing to provide all-directional seismic restraint.
2. Base: Factory drilled for bolting to structure.
3. Snubbers: Vertically adjustable to allow a maximum of 1/4-inch travel up or down before contacting a resilient collar.

H. Elastomeric Hangers: Single or double-deflection type, fitted with molded, oil-resistant elastomeric isolator elements bonded to steel housings with threaded connections for hanger rods. Color-code or otherwise identify to indicate capacity range.

I. Spring Hangers: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.
1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel- washer-reinforced cup to support spring and bushing projecting through bottom of frame.
7. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

J. Spring Hangers with Vertical-Limit Stop: Combination coil-spring and elastomeric- insert hanger with spring and insert in compression and with a vertical- limit stop.
1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without

deformation or failure.

6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
8. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

K. Pipe Riser Resilient Support: All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 1/2-inch-thick neoprene. Include steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions. Design support for a maximum load on the isolation material of 500 psig and for equal resistance in all directions.

L. Resilient Pipe Guides: Telescopic arrangement of 2 steel tubes or post and sleeve arrangement separated by a minimum of 1/2-inch-thick neoprene. Where clearances are not readily visible, a factory-set guide height with a shear pin to allow vertical motion due to pipe expansion and contraction shall be fitted. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.2 VIBRATION ISOLATION EQUIPMENT BASES

A. 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. Amber/Booth Company, Inc.
2. B-Line Systems, Inc.
3. Isolation Technology, Inc.
4. Kinetics Noise Control.
5. Mason Industries.
6. Vibration Eliminator Co., Inc.
7. Vibration Isolation.
8. Vibration Mountings & Controls, Inc.

C. Steel Base: Factory-fabricated, welded, structural-steel bases and rails.
1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
   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.

D. Inertia Base: Factory-fabricated, welded, structural-steel bases and rails ready for placement of cast-in-place concrete.
1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
   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.

2.3 FACTORY FINISHES

A. Finish: Manufacturer's standard prime coat finish ready for field painting.

B. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.
1. Powder coating on springs and housings.
2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
3. Baked enamel or powder coat for metal components on isolators for interior use.
4. Color-code or otherwise mark vibration isolation and seismic- and wind-control devices to indicate capacity range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic- and wind- control devices for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

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

3.2 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an evaluation service member of ICC-ES.

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 A will be adequate to carry present and future static and seismic loads within specified loading limits.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections

C. Tests and Inspections:
1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless post connection testing has been approved), and with at least seven days' advance notice.
3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
4. Test at least four or each type and size of installed anchors and fasteners selected by Architect.
5. Test to 90 percent of rated proof load of device.
6. Measure isolator restraint clearance.
7. Measure isolator deflection.
8. Verify snubber minimum clearances.
9. Air-Mounting System Leak Test: After installation, charge system and test for leaks. Repair

leaks and retest until no leaks exist.

10. Air-Mounting System Operational Test: Test the compressed-air leveling system.
11. Test and adjust air-mounting system controls and safeties.
12. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

3.4 ADJUSTING

A. Adjust isolators after piping system is at operating weight.

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

C. Adjust air-spring leveling mechanism.

D. Adjust active height of spring isolators.

E. Adjust restraints to permit free movement of equipment within normal mode of operation.

3.05 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-mounting systems. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 230548

SECTION 230553 - IDENTIFICATION for HVAC PIPING and EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Equipment labels.
2. Pipe labels.
3. Duct labels.
4. Stencils.
5. Valve 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. Metal Labels for Equipment:
1. Material and Thickness: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
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 self-tapping screws.
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, 1/8 inch thick, and having predrilled holes for attachment hardware.
2. Letter Color: Black.
3. Background Color: White.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F .
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch .
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches , 1/2 inch for viewing distances up to 72 inches , and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless-steel self-tapping screws.
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. Also, include the designation of the electrical panel that serves the respective piece of HVAC equipment. In the case of variable air volume boxes and fan powered variable air volume boxes also include the name and designation of the air handler that serves that particular box.

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. In the case of variable air volume boxes and fan powered variable air volume boxe also include the name and designation of the air handler that serves that particular box.

2.2 PIPE LABELS

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

B. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing. Do not use pipe labels or plastic tapes for bare pipes conveying fluids at temperatures of 125 deg F or higher.

C. 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 .

2.3 DUCT LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: Black.

C. Background Color: White.

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 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 .

2.4 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 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.

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.

C. All labels shall follow requirements of locally-adopted codes.

D. Furnsih and install equipment labels for all equipment, associated control panels and associated electrical panels. Ths shall include, but is not limited to:
1. Air Handling Units
2. Fans
3. VAV boxes
4. VFD enclosures
5. Starters
6. Control panels
7. Air flow measuring stations
8. Job site mounted control components

9. Control valves (except at the VAV boxes)

3.3 PIPE LABEL INSTALLATION

A. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. All labels shall follow requirements of locally-adopted codes. Install stenciled pipe labels with painted, color-coded bands or rectangles, complying with ASME A13.1, on each piping system.
1. Identification Paint: Use for contrasting background.
2. Stencil Paint: Use for pipe marking.

B. All labels shall follow requirements of locally-adopted codes. 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 30 feet along each run. Reduce intervals to 15 feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

C. Pipe Label Color Schedule:
1. Chilled-Water Piping:
   a. Background Color: Green.
   b. Letter Color: Black.
2. Heating Water Piping:
   a. Background Color: Yellow.
   b. Letter Color: Black.

3.4 DUCT LABEL INSTALLATION

A. Install self-adhesive duct labels with permanent adhesive on air ducts in the following color codes:
1. Blue: For cold-air supply ducts.
2. Yellow: For hot-air supply ducts.
3. Green: For exhaust-, outside-, relief-, return-, and mixed-air ducts.
4. ASME A13.1 Colors and Designs: For hazardous material exhaust. Fume Hood Exhaust Duct

B. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 20 feet in each space where ducts are exposed or concealed by removable ceiling system.

C. All labels shall follow requirements of locally-adopted codes.

3.5 VALVE-TAG INSTALLATION

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

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

1. Valve-Tag Size and Shape:
   a. Chilled Water: 1-1/2 inches, round.
   b. Hot Water: 1-1/2 inches, round.
2. Valve-Tag Color:
   a. Chilled Water: White.
   b. Hot Water: Black.
3. Letter Color:
   a. Chilled Water: White.
   b. Hot Water: Black.

END OF SECTION 230553

SECTION 230593 - TESTING, ADJUSTING, and BALANCING for HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SCOPE

A. This section provides for the testing and balancing of all systems and equipment, to be provided by 3rd parties hired by the Owner.

B. These tests are required to determine that all systems and equipment involved may be safely energized and function properly.

C. Perform tests by and under the supervision of fully experienced and qualified personnel. Advise each respective manufacturer's representative of tests on their equipment.

D. Record all test data.

E. Each section of Divisions 22 and 23 that has products or systems listed herein, incorporate this section by reference and is incomplete without the required tests stated herein.

1.3 SUMMARY

A. Section Includes:
   1. Balancing Air Systems:
      a. Constant-volume air systems.
      b. Variable-air-volume systems.

1.4 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.

1.5 SUBMITTALS

A. Qualification Data: Within 15 (fifteen) days of 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.

B. Contract Documents Examination Report: Within 30 (thirty) days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.

C. Strategies and Procedures Plan: Within 30 (thirty) days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.

D. Certified TAB reports.

E. Sample report forms.

F. 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 NEBB or TABB.
   1. TAB Field Supervisor: Employee of the TAB contractor and certified by NEBB or TABB.
   2. TAB Technician: Employee of the TAB contractor and who is certified by NEBB or TABB as a TAB technician.

B. TAB Conference: Meet with Construction Manager and on approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Require the participation of the TAB field supervisor and technicians. Provide seven days' advance notice of scheduled meeting time and location.
   1. Agenda Items:
      a. The Contract Documents examination report.
      b. The TAB plans.
      c. Coordination and cooperation of trades and subcontractors.
      d. Coordination of documentation and communication flow.

C. 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.

D. TAB Report Forms: Use standard TAB contractor's forms approved by Construction Manager.

E. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

F. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

G. 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.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.

B. Examine 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 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.

F. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

G. Examine test reports specified in individual system and equipment Sections.

H. 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.

I. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible, and their controls are connected and functioning.

J. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.

K. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

L. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

M. Examine system pumps to ensure absence of entrained air in the suction piping.

N. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 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.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance", ASHRAE 111, NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.
1. 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. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 233300 "Air Duct Accessories."
3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 230700 "HVAC Insulation".

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts within Mechanical Rooms.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling-unit components.

L. Verify that air duct system is sealed as specified in Section 233113 "Metal Ducts."

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
   1. Measure total airflow.
      a. 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, 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 Architect for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units

for adjustment of fans, belts, and pulley sizes as applicable to achieve indicated air-handling-unit performance.

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.
8. Adjust volume dampers for main duct, sub main ducts, and major branch ducts to indicate airflows within specified tolerances as applicable within work area.
9. Measure airflow of sub main and branch ducts.
   a. Where sufficient space in sub main 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.
10. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.
11. Remeasure each sub main and branch duct after all have been adjusted. Continue to adjust sub main and branch ducts to indicated airflows within specified tolerances.

B. Measure air outlets and inlets without adjusting.
   1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors as applicable.

3.6 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 to a 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. 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. Readjust fan airflow for final maximum readings.
   4. Measure operating static pressure at the sensor that controls the supply fan if one is installed and verify operation of the static-pressure controller.
   5. Measure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.

a. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.

3.7 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.

3.8 PROCEDURES FOR CONDENSING UNITS

A. Verify proper rotation of fans.

B. Measure entering- and leaving-air temperatures.

C. Record compressor data.

3.9 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 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.

3.10 TOLERANCES

A. Set HVAC system's air flow rates and water flow rates within the following tolerances:
1. Supply, Return, Outside Air and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
2. Heating-Water Flow Rate: Plus or minus 10 percent.
3. Cooling-Water Flow Rate: Plus or minus 10 percent.

3.11 REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

3.12 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. Fan curves.
   2. Manufacturers' test data.
   3. Field test reports prepared by system and equipment installers.
   4. Other information related 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 fan 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 include 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 (mm), and bore.
i. Center-to-center dimensions of sheave, and number of adjustments in inches (mm).
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 (mm), and bore.
f. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).
3. Test Data (Indicated and Actual Values):
a. Total air flow rate in cfm (L/s).
b. Total system static pressure in inches wg (Pa).
c. Fan rpm.
d. Discharge static pressure in inches wg (Pa).
e. Filter static-pressure differential in inches wg (Pa).
f. Preheat-coil static-pressure differential in inches wg (Pa).
g. Cooling-coil static-pressure differential in inches wg (Pa).
h. Heating-coil static-pressure differential in inches wg (Pa).
i. Outdoor airflow in cfm (L/s).
j. Return airflow in cfm (L/s).
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 (mm) o.c.
f. Make and model number.
g. Face area in sq. ft. (sq. m).
h. Tube size in NPS (DN).
i. Tube and fin materials.
j. Circuiting arrangement.

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

G. Fan Test Reports: For supply, return, and exhaust fans, include the following:
1. Fan Data:
a. System identification.
b. Location.
c. Make and type.
d. Model number and size.
e. Manufacturer's serial number.
f. Arrangement and class.
g. Sheave make, size in inches (mm), and bore.
h. Center-to-center dimensions of sheave, and number of adjustments in inches (mm).

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 (mm), and bore.
f. Center-to-center dimensions of sheave, and number of adjustments in inches (mm).
g. Number, make, and size of belts.

3. Test Data (Design and Actual Values):
a. Total airflow rate in cfm (L/s).
b. Total system static pressure in inches wg (Pa).
c. Fan rpm.
d. Discharge static pressure in inches wg (Pa).

e. Suction static pressure in inches wg (Pa).

H. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
1. Report Data:
a. System and air-handling-unit number.
b. Location and zone.
c. Traverse air temperature in deg F (deg C).
d. Duct static pressure in inches wg (Pa).
e. Duct size in inches (mm).
f. Duct area in sq. ft. (sq. m).
g. Indicated air flow rate in cfm (L/s).
h. Indicated velocity in fpm (m/s).
i. Actual air flow rate in cfm (L/s).
j. Actual average velocity in fpm (m/s).
k. Barometric pressure in psig (Pa).

I. Air-Terminal-Device Reports:
1. Unit Data:
a. System and air-handling unit identification.
b. Location and zone.
c. Apparatus used for test.
d. Area served.
e. Make.
f. Number from system diagram.
g. Type and model number.
h. Size.
i. Effective area in sq. ft. (sq. m).
2. Test Data (Design and Actual Values):
a. Air flow rate in cfm (L/s).
b. Air velocity in fpm (m/s).
c. Preliminary air flow rate as needed in cfm (L/s).
d. Preliminary velocity as needed in fpm (m/s).
e. Final air flow rate in cfm (L/s).
f. Final velocity in fpm (m/s).
g. Space temperature in deg F (deg C).

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

3.13 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 the 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 Architect.
2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of Architect.
3. The architect 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.
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 adjust. 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.

3.14 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 230700 - HVAC INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Insulation Materials:
a. Cellular glass (Foamglass)
b. Flexible elastomeric (Black Rubber Insulation)
c. Mineral fiber (Fiberglass)
2. Insulating cement.
3. Adhesives.
4. Mastics.
5. Lagging adhesives.
6. Sealants.
7. Factory-applied jackets.
8. Field-applied fabric-reinforcing mesh.
9. Field-applied cloths.
10. Field-applied jackets.
11. Tapes.
12. Securements.
13. Corner angles.

B. Related Sections:
1. Section 233113 "Metal Ducts."
2. Section 232300 "Refrigerant Piping."

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 insulation application at pipe expansion joints for each type of insulation.
3 Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
4 Detail removable insulation at piping specialties, equipment connections, and access panels.
5 Detail application of field-applied jackets.
6 Detail application at linkages of control devices.
7 Detail field application for each equipment type.

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.

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.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by the 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 Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

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

C. Refer to section 230500 Common Work Results for HVAC.

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. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Inculations shall be suitable for applications at temperatures between ZERO deg F to PLUS 450 deg F. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article. Foamglass pipe insulation shall equal to HLB 1200. Insulate fittings associated with foamglass insulation systems with molded, pipe fitting fitting covers with same thickness as adjoining pipe insulation and shall be covered with molded, 25/50, PVC, Zeston fitting covers. Insulate valves associated with foamglass insulation systems with fire retardent, 1" thick, 25/30/50, black, closed cell, foam plastic insulation equal to Armaflex FR insulation applied with mastic approved by the insulation manufacturer.
1. Block Insulation: ASTM C 552, Type I.
2. Special-Shaped Insulation: ASTM C 552, Type III.
3. Board Insulation: ASTM C 552, Type IV.
4. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
5. Preformed Pipe Insulation with Factory-Applied ASJ ASJ-SSL: Comply with ASTM C 552, Type II, Class 2.
6. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

G. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Insulation shall be suitable for applicable at temperatures between MINUS 70 deg F and PLUS 220 deg F. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.

H. 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. Insulation shall be suitable for application at temperatures between PLUS 40 deg F to PLUS 250 deg F. Factory-applied jacket requirements are specified in the "Factory-Applied Jackets" Article.

I. The entire insulation system and all insulating materials insulation, coverings, jackets, cements, adhesives, miscellaneous items, and accessories, etc. shall have a maximum flame spread rating of 25, a maximum fuel contribution rating

of 30 and a maximum smoke developmental rating of 50 and shall be suitable for installation in a plenum.

2.2 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.

C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.

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. Cellular-Glass, Phenolic, Polyisocyanurate, and Polystyrene Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.
1. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D EPA Method 24.

C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
1. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D EPA Method 24.

D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
1. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D EPA Method 24.

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

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.
1. For indoor applications, use mastics that have a VOC content that is compliant with the requirements of 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. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F .
3. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
4. Color: White.

C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below ambient services.
   1. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
   2. Service Temperature Range: 0 to 180 deg F .
   3. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
   4. Color: White.

D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below ambient services.
   1. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
   2. Service Temperature Range: Minus 50 to plus 220 deg F .
   3. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
   4. Color: White.

E. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
   1. Water-Vapor Permeance: ASTM F 1249, 3 perms at 0.0625-inch dry film thickness.
   2. Service Temperature Range: Minus 20 to plus 200 deg F .
   3. Solids Content: 63 percent by volume and 73 percent by weight.
   4. 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 that is compliant with the requirements of 40 CFR 59, Subpart D EPA Method 24.
   2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct, equipment, and pipe insulation.
   3. Service Temperature Range: Minus 50 to plus 180 deg F .
   4. Color: White.

2.6 SEALANTS

A. Joint Sealants:
   1. Materials shall be compatible with insulation materials, jackets, and substrates.
   2. Permanently flexible, elastomeric sealant.
   3. Service Temperature Range: Minus 100 to plus 300 deg F .
   4. Color: White or gray.
   5. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D EPA Method 24.

B. FSK and Metal Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F .
4. Color: Aluminum.
5. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D EPA Method 24.

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F .
4. Color: White.
5. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D EPA Method 24.

2.7 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
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.
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.
6. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.

2.8 FIELD-APPLIED FABRIC-REINFORCING MESH

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

2.9 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. .

2.10 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. Metal Jacket:
1. Aluminum Jacket: Comply with ASTM B 209 , Alloy 3003, 3005, 3105 or 5005, Temper H-14.
a. Factory cut and rolled to size.
b. Finish and thickness are indicated in field-applied jacket schedules.
c. Moisture Barrier for Indoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
e. Factory-Fabricated Fitting Covers:
1) Same material, finish, and thickness as jacket.
2) Preformed 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.

D. 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 white aluminum-foil facing.

E. 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.

F. 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.

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

2.11 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
1. Width: 3 inches .
2. Thickness: 11.5 mils .
3. Adhesion: 90 ounces force/inch in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch in width.

6. 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. Width: 3 inches .
2. Thickness: 6.5 mils .
3. Adhesion: 90 ounces force/inch in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch in width.
6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Width: 2 inches .
2. Thickness: 3.7 mils .
3. Adhesion: 100 ounces force/inch in width.
4. Elongation: 5 percent.
5. Tensile Strength: 34 lbf/inch in width.

D. PVDC Tape for Indoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.
1. Width: 3 inches .
2. Film Thickness: 4 mils .
3. Adhesive Thickness: 1.5 mils .
4. Elongation at Break: 145 percent.
5. Tensile Strength: 55 lbf/inch in width.

E. PVDC Tape for Outdoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.
1. Width: 3 inches .
2. Film Thickness: 6 mils .
3. Adhesive Thickness: 1.5 mils .
4. Elongation at Break: 145 percent.
5. Tensile Strength: 55 lbf/inch in width.

2.12 SECUREMENTS

A. Bands:
1. 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.
2. Aluminum: ASTM B 209 , Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing or closed seal.
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, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
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.

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. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
   b. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
   c. 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. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
   b. Spindle: Nylon, 0.106-inch- diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches .
   c. 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. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
   b. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
   c. Adhesive-backed base with a peel-off protective cover.
6. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
   a. 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.

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

D. Wire: 0.080-inch nickel-copper alloy.

2.13 CORNER ANGLES

A. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch , aluminum according to ASTM B 209, Alloy 3003, 3005, 3105 or 5005; Temper H-14.

PART 3 - EXECUTION

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

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

3.3 GENERAL INSTALLATION REQUIREMENTS

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

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

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

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

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

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

G. Keep insulation materials dry during application and finishing.

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

I. Install insulation with the least number of joints practical.

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

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

L. Install insulation with factory-applied jackets as follows:
   1. Draw jacket tight and smooth.
   2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
   3. Overlap jacket longitudinal seams at least 1-1/2 inches . Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
      a. For below ambient services, apply vapor-barrier mastic over staples.
   4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
   5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above ambient services, do not install insulation to the following:
   1. Vibration-control devices.
   2. Testing agency labels and stamps.
   3. Nameplates and data plates.

4. Manholes.
5. Handholes.
6. Cleanouts.

Q. Piping insulation on all inline mounted P/T ports, circuit setters / calibrated balancing valve pressure ports, strainers, etc. shall be made easily removable so that access to the ports can be readily obtained without destroying the insulation and the strainer baskets can be removed and cleaned without destroying the insulation.

R. Airflow measuring station pressure ports, access door handles, duct mounted instrumentation, etc., shall be left exposed on warm systems and accessible above the insulation vapor barrier on cold and hot systems.

3.4 PENETRATIONS

A. 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.

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

C. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions. Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches .
1. Comply with requirements in Division 07 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

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. 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.
6. Provide removeable insulation covers on the ends of suction diffusers to facilitate the cleaning of the strainers inside the suction diffusers.

3.6 CELLULAR-GLASS (FOAMGLASS) INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of 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 services, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below ambient services, 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 cut sections of cellular-glass block insulation of same thickness as pipe 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. Secure according to manufacturer's written instructions.
2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed sections of cellular-glass insulation to valve body.

2. 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.

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 (FIBERGLASS) INSULATION INSTALLATION

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 a minimum of 75 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
b. On duct sides with dimensions larger than 18 inches , place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
d. Do not overcompress insulation during installation.
e. Impale insulation over pins and attach speed washers.
f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
   a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
   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 2 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.

3.9 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 the same material as jacket.
3. Secure jacket to insulate 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 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

E. Where PVDC jackets are indicated, install as follows:
1. Apply three separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.
2. Wrap factory-presized jackets around individual pipe insulation sections with one end overlapping the previously installed sheet. Install presized jacket with an approximate overlap at butt joint of 2 inches over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.
3. Continuous jacket can be spiral wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When choosing 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. Duct, 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 DUCT INSULATION SCHEDULE, GENERAL

A. R-value shall meet requirements of latest adopted version of the International Energy Conservation Code or values listed in this specification, whichever is stricter.

B. Ducts Requiring Insulation with flexible duct wrap:
1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.
3. Indoor, concealed return.
4. Indoor, exposed return.
5. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
6. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
7. Interior surfaces of blank off plates behind louvers or damper openings where existing openings are closed off. Refer to the Drawings.

C. Items Not Insulated:
1. Factory-insulated flexible ducts.
2. Factory-insulated plenums and casings.
3. Flexible connectors.
4. Vibration-control devices.
5. Factory-insulated access panels and doors.

3.12 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Concealed, round, rectangular and flat-oval, supply-air duct insulation shall be the following:
1. Mineral-Fiber Blanket: 2 inches thick and 1.00-lb/cu. ft. nominal density.

B. Exposed, round, rectangular and flat-oval, supply-air duct insulation shall be the following:
1. Mineral-Fiber Blanket: 2 inches thick and 1.00-lb/cu. ft. nominal density.

C. Exposed, round, rectangular and flat-oval, return-air duct insulation shall be the following:
1. Mineral-Fiber Blanket: 2 inches thick and 1.00-lb/cu. ft. nominal density.

D. Exposed, round, rectangular and flat-oval, outdoor-air duct insulation, as well as blank off plates, shall be the following:
1. Mineral-Fiber Blanket: 2 inches thick and 1.00-lb/cu. ft. nominal density.

3.13 PIPING INSULATION SCHEDULE, GENERAL

A. R-value, thickness, and conductivity shall meet requirements of latest adopted version of the International Energy Conservation Code or values listed in this specification, whichever is stricter.

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

3.14 INDOOR PIPING INSULATION SCHEDULE

A. Condensate and Equipment Drain Water below 60 Deg F :
1. All Pipe Sizes: Insulation shall be the following:
a. Fire-Wrap: 1/2 inch thick.
b. Flexible Elastomeric: 1 inch thick.

B. Chilled Water, above 40 Deg F:
1. NPS 8 and Smaller: Insulation shall be:
a. Mineral Fiber ASJ-SSL: 2 inches thick.
2. NPS 1 inch and smaller: Insulation shall be the following:
a. Mineral Fiber ASJ-SSL: 1 inch thick.

C. Heating-Hot-Water Supply and Return, 220 Deg F and below:
1. NPS 8 through 1-1/4 inch: Insulation shall be the following:
a. Mineral Fiber ASJ-SSL: 2 inches thick
2. NPS 1 inch and smaller: Insulation shall be the following:
a. Mineral Fiber ASJ-SSL: 1 inch thick

D. All cold surfaces associateed with the HVAC system (materials, piping, ductwork or equipment) subject to sweating shall be insulated and provided with an external vapor barrier to a sufficient degree so as not to sweat under the normal conditions of use.

3.15 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Chilled, Hot Water Piping, Condensate Drains, Refrigerant Suction Piping, VRF Refrigerant Piping:
1. All Pipe Sizes: Insulation shall be one of the following:
a. Cellular Glass: 2 inches thick (chilled water, heating hot water).
b. Flexible Elastomeric: 2 inches thick (condensate drains, refrigerant suction piping, all VRF refrigerant piping).

3.16 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. Exposed, Chilled, Hot, Condensate Piping:
1. Aluminum, Corrugated, 0.040 inch thick.

3.17 FIRE-RATED INSULATION SYSTEMS

A. Fire-Rated Blanket: High Temperature, flexible, single-layer blanket insulation with FSK jacket that is tested and certified to provide a 2-hour Fire Rating by a NRTL acceptable to the A.H.J. Fire-Rated flexible blanket to be UNIFRAX, FYREWRAP 1.5, or equal.

END OF SECTION 230700

SECTION 232300 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes refrigerant piping used for air-conditioning applications.

1.3 PERFORMANCE REQUIREMENTS

A. Line Test Pressure for Refrigerant R-410A:
   1. Suction Lines for Air-Conditioning Applications: 300 psig (2068 kPa).
   2. Suction Lines for Heat-Pump Applications: 535 psig (3689 kPa).
   3. Hot-Gas and Liquid Lines: 535 psig (3689 kPa).

1.4 SUBMITTALS

A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop, based on manufacturer's test data, for the following:
   1. Filter dryers.

B. Shop Drawings: Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment.
   1. Shop Drawing Scale: 1/4 inch equals 1 foot (1:50).
   2. Refrigerant piping indicated on Drawings is schematic only. Size piping and design actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.

1.5 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."

C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.8 PRODUCT STORAGE AND HANDLING

A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

1.9 COORDINATION

A. Coordinate size and location of equipment supports. This Contractor is responsible for support of his equipment. Submit details to the Architect for approval.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Copper Tube: ASTM B 88, Type K.

B. Wrought-Copper Fittings: ASME B16.22.

C. Wrought-Copper Unions: ASME B16.22.

D. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.

E. Brazing Filler Metals: AWS A5.8.

F. Flexible Connectors:
1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
2. End Connections: Socket ends.
3. Offset Performance: Capable of minimum 3/4-inch (20-mm) misalignment in minimum 7-inch- (180-mm-) long assembly.
4. Pressure Rating: Factory test at minimum 500 psig (3450 kPa).
5. Maximum Operating Temperature: 250 deg F (121 deg C).

G. 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:

H. Manufacturers: Subject to compliance with manufacturer requirements, provide products by one of the following:
1. Atofina Chemicals, Inc.
2. DuPont Company; Fluorochemicals Div.
3. Honeywell, Inc.; Genetron Refrigerants.
4. INEOS Fluor Americas LLC.

I. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS FOR REFRIGERANT R-410A

A. Suction Lines NPS 1-1/2 (DN 40) and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.

B. Suction Lines NPS 2 to NPS 3-1/2 (DN 50 to DN 90) for Conventional Air-Conditioning Applications: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed joints.

C. Safety-Relief-Valve Discharge Piping: Copper, Type L, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.

3.2 PIPING INSTALLATION

A. Install all piping per manufacturer's recommendation.

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 Shop Drawings.

C. Install refrigerant piping according to ASHRAE 15.

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. Install piping adjacent to machines to allow service and maintenance.

H. Install piping free of sags and bends.

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

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

K. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

L. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Section 083100 "Access Doors and Panels" if valves or equipment requiring maintenance is concealed behind finished surfaces.

M. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

N. Slope refrigerant piping as manufacturer recommends.

O. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

P. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

Q. Identify refrigerant piping and valves according to Section 230553 "Identification for HVAC Piping and Equipment."

R. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified hereinbefore.

3.3 PIPE JOINT CONSTRUCTION

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

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

C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.

D. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
   1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
   2. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.

3.4 HANGERS AND SUPPORTS

A. Hanger, support, and anchor products are specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Install the following pipe attachments:
   1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet (6 m) long.
   2. Roller hangers and spring hangers for individual horizontal runs 20 feet (6 m) or longer.
   3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet (6 m) or longer, supported on a trapeze.
   4. Spring hangers to support vertical runs.
   5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

C. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:
   1. NPS 1/2 (DN 15): Maximum span, 60 inches (1500 mm); minimum rod size, 1/4 inch (6.4 mm).
   2. NPS 5/8 (DN 18): Maximum span, 60 inches (1500 mm); minimum rod size, 1/4 inch (6.4 mm).
   3. NPS 1 (DN 25): Maximum span, 72 inches (1800 mm); minimum rod size, 1/4 inch (6.4 mm).
   4. NPS 1-1/4 (DN 32): Maximum span, 96 inches (2400 mm); minimum rod size, 3/8 inch (9.5 mm).
   5. NPS 1-1/2 (DN 40): Maximum span, 96 inches (2400 mm); minimum rod size, 3/8 inch (9.5 mm).
   6. NPS 2 (DN 50): Maximum span, 96 inches (2400 mm); minimum rod size, 3/8 inch (9.5 mm).
   7. NPS 2-1/2 (DN 65): Maximum span, 108 inches (2700 mm); minimum rod size, 3/8 inch (9.5 mm).
   8. NPS 3 (DN 80): Maximum span, 10 feet (3 m); minimum rod size, 3/8 inch (9.5 mm).
   9. NPS 4 (DN 100): Maximum span, 12 feet (3.7 m); minimum rod size, 1/2 inch (13 mm).

D. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
   1. NPS 2 (DN 50): Maximum span, 10 feet (3 m); minimum rod size, 3/8 inch (9.5 mm).
   2. NPS 2-1/2 (DN 65): Maximum span, 11 feet (3.4 m); minimum rod size, 3/8 inch (9.5 mm).
   3. NPS 3 (DN 80): Maximum span, 12 feet (3.7 m); minimum rod size, 3/8 inch (9.5 mm).
   4. NPS 4 (DN 100): Maximum span, 14 feet (4.3 m); minimum rod size, 1/2 inch (13 mm).

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:
   1. Comply with ASME B31.5, Chapter VI.
   2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
   3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.
      a. Fill system with nitrogen to the required test pressure.
      b. System shall maintain test pressure at the manifold gage throughout duration of test.
      c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
      d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

3.6 SYSTEM CHARGING

A. Charge system using the following procedures:
   1. Install core in filter dryers after leak test but before evacuation.

2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers (67 Pa). If the vacuum holds for 12 hours, system is ready for charging.
3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig (14 kPa).
4. Charge system with a new filter-dryer core in charging line.

3.7 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.

B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.

D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
1. Verify that compressor oil level is correct.
2. Open compressor suction and discharge valves.
3. Open refrigerant valves except bypass valves that are used for other purposes.

E. Replace core of replaceable filter dryer, as applicable, after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION 232300

SECTION 233113 - METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Single-wall rectangular ducts and fittings.
   2. Single-wall round and flat-oval ducts and fittings.
   3. Double-wall rectangular ducts and fittings.
   4. Double-wall round ducts and fittings
   5. Sheet metal materials.
   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.

1.3 PERFORMANCE REQUIREMENTS

A. 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.
   1. Static-Pressure Classes:
      a. Rectangular Supply Ducts Upstream of Air Terminal Units: 4-inch wg
      b. Round and Flat Oval Supply Ducts Upstream of Air Terminal Units: 4-inch wg.
      c. Supply Ducts Downstream of Air Terminal Units: 1-inch wg.
      d. Supply Ducts in Mechanical Equipment Rooms: 4-inch wg.
      e. Return Ducts Negative Pressure: 1-inch wg.
      f. Exhaust Ducts Negative Pressure: 1-inch wg.
      g. Outside Air Ducts: 1-inch wg.
   2. Leakage Class: Meet or exceed SMACNA Duct Construction Standards for air leakage.
      a. Round Supply-Air Duct Downstream of Air Terminal Units: 3 cfm/100 sq. ft. at 1-inch wg.
      b. Round and Flat-Oval Supply-Air Duct Upstream of Air Terminal Units: 3 cfm/100 sq. ft. at 4-inch wg.
      c. Rectangular Supply-Air Duct Upstream of Air Terminal Units: 6 cfm/100 sq. ft. at 5-inch wg.
      d. Flexible Supply-Air Duct: 6 cfm/100 sq. ft. at 6-inch wg.
      e. Seal all ductwork per SMACNA duct leakage Class “A” (seal all ductwork joints and seal all ductwork seams, except machine made spiral lock seams).

B. Structural Performance: Duct hangers and supports shall withstand the effects of gravity under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible".

C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

D. UL 181 pre-insulated flexible ductwork may be used for final alignment between ductwork and diffusers/registers. Max length 3'-0". Avoid sags or sharp offsets.

1.4 SUBMITTALS

A. Product Data: For each type of the following products:
1. Adhesives.
2. Sealants and gaskets.
3. Ductwork.
4. Joining methods.

B. Shop Drawings:
1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
4. Elevation of top of ducts.
5. Dimensions of main duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment, and vibration isolation.

C. 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. Provide coordination drawings for all air handling rooms. Also provide sections through all air handling rooms.
2. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
3. Suspended ceiling components.
4. Structural members to which duct will be attached.
5. Size and location of initial access modules for acoustical tile.
6. Penetrations of smoke barriers and fire-rated construction.

D. Comply with Section 230500 "Common Work Results for HVAC".

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:
1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.

2. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."

C. 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 1-4, "Transverse Girth Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 2, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 SINGLE-WALL ROUND AND FLAT-OVAL 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. Single wall round and flat oval ducts shall be fabricated with machine made, continuous, spial seams.

B. Flat-Oval Ducts: Indicated dimensions are the duct width major dimension and diameter diameter of the round sides connecting the flat portions of the duct.

C. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round Duct," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
   1. Transverse Joints in Ducts Larger Than 48 Inches in Diameter: Flanged.

D. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Seams - Round Duct and

Fittings," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

E. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
   1. Galvanized Coating Designation: G90.
   2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; galvanized.

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 .

2.4 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Water-Based Joint and Seam Sealant:
   1. Application Method: Brush on.
   2. Solids Content: Minimum 65 percent.
   3. Shore A Hardness: Minimum 20.
   4. Water resistant.
   5. Mold and mildew resistant.
   6. VOC: Maximum 75 g/L (less water).
   7. Maximum Static-Pressure Class: 10-inch wg , positive and negative.
   8. Service: Indoor or outdoor.
   9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

C. 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. VOC: Maximum 395 g/L.
9. Maximum Static-Pressure Class: 10-inch wg , positive or negative.
10. Service: Indoor or outdoor.
11. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Flanged Joint Sealant: Comply with ASTM C 920.
1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.

E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

2.5 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts. Black hanger rod and black hardware are unacceptable and shall not be used on this project.

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 4-1 , "Rectangular Duct Hangers Minimum Size," and Table 4-2, "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.

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. All 90 degree branch take offs from round ductwork shall be made with conical taps and all round take offs from rectangular ductwork shall be made with bellmouth fittings allas set forth in 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 min. clearance of 1 inch , plus allowance for insulation thickness.

I. Route ducts to avoid passing through transformer vaults, elevator 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 "Duct Cleanliness for New Construction Guidelines."

M. Locate all balancing dampers in accessible locations to allow for balancing of the systems. If this is not possible provide inaccessible balancing dampers with remote damper actuators (Young Regulator Company, 5020-CC, 830-CC, 270-301, or equal). The exact locations of the remote damper actuator devices shall be determined at the job site during the course of the project.

3.2 DUCT SEAM AND JOINT SEALING

A. Seal all duct seams and all duct joints, except for machine made spiral seams and seams in transfer air ductwork, with high pressure duct sealer to exceed SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," for ductwork sealing classification “A”.

3.3 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
   1. Where practical, install concrete inserts before placing concrete.
   2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
   3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
   4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
   5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1 , "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet .

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.4 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.

3.5 DUCT SCHEDULE

A. Fabricate ducts utilizing galvanized sheet steel - all services.

B. Liner:
   1. Transfer Ducts: Fibrous glass, Type I Flexible elastomeric, 1" thick unless otherwise indicated on plans.

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. Manual volume dampers
2. Control dampers
3. Fire dampers
4. Combination fire and smoke dampers
5. Flange connectors
6. Turning vanes
7. Remote damper operators
8. Duct-mounted access doors
9. Flexible connectors
10. Flexible ducts
11. Duct accessory hardware

B. Related Sections:
1. Section 283111 "Digital, Addressable Fire-Alarm System".

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.
1. Manual dampers.
2. Fire dampers.
3. Fire/smoke dampers.
4. Flexible connectors.
5. Accessories.

B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.
1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
a. Special fittings.
b. Manual volume damper installations.
c. Control damper installations.
d. Fire-damper, smoke-damper, combination fire- and smoke-damper, installations, including sleeves; and duct-mounted access doors, as well as remote damper operators.
e. Wiring Diagrams: For power, signal, and control wiring.

C. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

D. Refer to Section 230500 "Common Work Results for HVAC."

1.4 QUALITY ASSURANCE

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems".

B. Comply with AMCA 500-D testing for damper rating.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653.
1. Galvanized Coating Designation: G90 .
2. Exposed-Surface Finish: Mill phosphatized.

C. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304, and having a mill finish for concealed ducts and No. 4 finish for exposed ducts.

D. 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.

E. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.

F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

G. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.2 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:
1. Standard leakage rating, with linkage outside airstream.
2. Suitable for horizontal or vertical applications.
3. Frames:
   a. Hat-shaped, galvanized-steel channels, 0.064-inch minimum thickness.
   b. Mitered and welded corners.
   c. Flanges for attaching to walls and flangeless frames for installing in ducts.
4. Blades:
   a. Multiple or single blade. (max. 8" single blade)
   b. Parallel-blade or opposed-blade design.
   c. Stiffen damper blades for stability.
   d. Galvanized steel, 0.064 inch thick.
5. Blade Axles: Stainless steel.
6. Bearings:
   a. Oil-impregnated bronze.
   b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
7. Tie Bars and Brackets: Galvanized steel.
8. Provide manual volume dampers installed in externally wrapped ductwork with a stand-off bracket and locking quadrant to ensure that the handle can be adjusted without disturbing the insulation vapor barrier.
9. Manual volume damper (MVD) blades shall be constructed of 16 gauge minimum thickness metal.

B. Jackshaft:
1. Size: 1-inch diameter.

2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

C. Damper Hardware:
1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch- thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
2. Include center hole to suit damper operating-rod size.
3. Include elevated platform for insulated duct mounting.

2.3 CONTROL DAMPERS

A. Ultra-low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.

B. Frames:
1. Hat or U or Angle shaped.
2. Galvanized-steel channels, 0.064 inch thick.
3. Mitered and welded corners.

C. Blades:
1. Multiple blade with maximum blade width of 8 inches .
2. Opposed-blade design.
3. Stainless steel.
4. 0.064 inch thick.
5. Blade Edging: Closed-cell neoprene edging.

D. Blade Axles: 1/2-inch- diameter; stainless steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.
1. Operating Temperature Range: From minus 40 to plus 200 deg F .

F. Bearings:
1. Oil-impregnated bronze.
2. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
3. Thrust bearings at each end of every blade.

2.4 FIRE DAMPERS

A. Type: Dynamic ; rated and labeled according to UL 555 by an NRTL.

B. Closing rating in ducts up to 6-inch wg static pressure class and minimum 4000-fpm velocity.

C. Fire Rating: 1-1/2 hours.

D. Frame: Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream; fabricated with roll-formed, 0.034-inch- thick galvanized steel; with mitered and interlocking corners.

E. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
1. Minimum Thickness: thickness shall be as required to meet all applicable code requirements and of length to suit application.

F. Mounting Orientation: Vertical or horizontal as indicated.

G. Blades: Roll-formed, interlocking, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.

H. Horizontal Dampers: Include blade lock and stainless-steel closure spring.

2.5 COMBINATION FIRE AND SMOKE DAMPERS

A. Type: Dynamic ; rated and labeled according to UL 555 and UL 555S by an NRTL.

B. Closing rating in ducts up to 6-inch wg static pressure class and minimum 4000-fpm velocity.

C. Fire Rating: 1-1/2 hours.

D. Frame: Multiple-blade type; fabricated with roll-formed, 0.034-inch- thick galvanized steel; with mitered and interlocking corners.

E. Heat-Responsive Device: Electric remote resettable link and switch package, factory installed, rated.

F. Blades: Roll-formed, horizontal, interlocking, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.

G. Leakage: Class I.

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. Thickness of sleeve shall be as required to meet all applicable code requirements. Provide with factory-furnished silicone calking if required by authorities having jurisdiction.

J. Damper Motors: Two-position action.

K. Motors:
1. Motor Sizes: Motors shall be 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 Section 230900 "Instrumentation and Control for HVAC" and applicable Division 26 Sections.
3. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf .
4. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F .
5. Electrical Connection: Coordinate motor electrical characterics with the electrical Division.

L. Accessories:
1. Auxiliary switches for signaling, fan control, and position indication.
2. Test and reset switches, damper and remote mounted.

2.6 FLANGE CONNECTORS

A. Description: Add-on or roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.

B. Material: Galvanized steel.

C. Gage and Shape: Match connecting ductwork.

2.7 TURNING VANES

A. 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.

B. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and flexible"; Figures 2-3, "Vanes and Vane Runners," and 2-4, "Vane Support in Elbows."

C. Vane Construction: Single wall for ducts up to 48 inches wide and double wall for larger dimensions. Provide turning vanes with extended trailing edge.

2.8 REMOTE DAMPER OPERATORS

A. Description: Cable system designed for remote manual damper adjustment.

B. Tubing: Brass.

C. Cable: Stainless steel.

D. Wall-Box Mounting: Recessed, 2 inches deep.

E. Wall-Box Cover-Plate Material: Stainless steel.

2.9 DUCT-MOUNTED ACCESS DOORS

A. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-10, "Duct Access Doors and Panels," and 2-11, "Access Panels - Round Duct."
   1. Door:
      a. Double wall, rectangular.
      b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
      c. Vision panel.
      d. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
      e. Fabricate doors airtight and suitable for duct pressure class.
   2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
   3. Number of Hinges and Locks:
      a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
      b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.
      c. Access Doors up to 24 by 48 Inches : Three hinges and two compression latches with outside and inside handles.
      d. Access Doors Larger Than 24 by 48 Inches : Four hinges and two compression latches with outside and inside handles.

B. Pressure Relief Access Door:
   1. Door and Frame Material: Galvanized sheet steel.
   2. Door: Double wall with insulation fill with metal thickness applicable for duct pressure class.
   3. Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts.
   4. Factory set at 4-inch wg.
   5. Doors close when pressures are within set-point range.
   6. Hinge: Continuous piano.
   7. Latches: Cam.

8. Seal: Neoprene or foam rubber.
9. Insulation Fill: 1-inch- thick, fibrous-glass or polystyrene-foam board.

2.10 FLEXIBLE CONNECTORS

A. Materials: Flame-retardant or noncombustible fabrics.

B. Coatings and Adhesives: Comply with UL 181, Class 1.

C. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
1. Minimum Weight: 26 oz./sq. yd. .
2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F .

D. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.
1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
2. Outdoor Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

2.11FLEXIBLE DUCTS

A. Insulated, Flexible Duct: UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound, spring-steel wire; fibrous-glass insulation; 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 20 to plus 210 deg F .
4. Insulation R-value: Comply with ASHRAE/IESNA 90.1-2004.

B. Maximum length 3'-0". Use only for final alignment between diffusers and ductwork.

C. Flexible Duct Connectors:
1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches , to suit duct size.

2.12DUCT 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.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
   1. Install steel volume dampers in steel ducts.

D. Set dampers to fully open position before testing, adjusting, and balancing.

E. Install test holes at fan inlets and outlets and elsewhere as indicated.

F. Install fire dampers according to UL listing.

G. 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. Upstreamand downstream from duct filters.
   3. At outdoor-air intakes and mixed-air plenums.
   4. At drain pans and seals.
   5. Downstream from control dampers and equipment.
   6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
   7. At each change in direction and at maximum 50-foot spacing.
   8. Control devices requiring inspection.
   9. Elsewhere as indicated.

H. Install access doors with swing against duct static pressure.

I. Access Door Sizes (Doors to be as large as possible):
   1. Two-Hand Access: 16 by 10 inches .
   2. Head and Hand Access: 20 by 14 inches .
   3. Head and Shoulders Access: 24 by 18 inches .

J. Label access doors according to Section 230533 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

K. Install flexible connectors to connect ducts to equipment.

L. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

M. Connect terminal units to supply ducts with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.

N. Connect diffusers to ducts with maximum 24-inch lengths of flexible duct clamped or strapped in place.

O. Connect flexible ducts to metal ducts with draw bands . The maximum length of flexible duct allowed on this project is 3'-0". Install flexible duct as straight as possible. Do not install flexible duct with bends or offsets. Flexible ducts are not to be used as elbows, fittings or major offsets but are to be used for minor alignment purposes.

P. Install duct test holes where required for testing and balancing purposes.

Q. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:
1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation.
5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION 233000

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. Propeller fans.

1.3 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base fan-performance ratings on actual Project site elevation.

B. Operating Limits: Classify according to AMCA 99.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Also include the following:
1. Certified fan performance curves with system operating conditions indicated.
2. Certified fan sound-power ratings.
3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
4. Material thickness and finishes, including color charts.
5. Dampers, including housings, linkages, and operators.
6. Roof curbs.
7. Fan speed controllers.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.

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 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.

C. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.

1.8 COORDINATION

A. Coordinate size and location of structural-steel support members.

PART 2 - PRODUCTS

2.1 CEILING-MOUNTED VENTILATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following
1. Broan-NuTone LLC; NuTone Inc.
2. Carnes Company.
3. FloAire.
4. Greenheck Fan Corporation.
5. Loren Cook Company.
6. PennBarry.
7. W.W. Grainger, Inc.; Dayton Products.

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: Painted aluminum, louvered grille with flange on intake and thumbscrew attachment to fan housing.

E. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.

F. Accessories:
1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
2. Manual Starter Switch: Single-pole rocker switch assembly with cover and pilot light.

3. Time-Delay Switch: Assembly with single-pole rocker switch, timer, and cover plate.
4. Motion Sensor: Motion detector with adjustable shutoff timer.
5. Ceiling Radiation Damper: Fire-rated assembly with ceramic blanket, stainless-steel springs, and fusible link.
6. Filter: Washable aluminum to fit between fan and grille.
7. Isolation: Rubber-in-shear vibration isolators.
8. Manufacturer's standard roof jack or wall cap, and transition fittings.

G. Capacities and Characteristics:
1. Refer to Schedule on Plans.

2.2 PROPELLER FANS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following.
1. Acme Engineering & Manufacturing Corporation.
2. Greenheck Fan Corporation.
3. Loren Cook Company.
4. PennBarry.

B. Housing: Galvanized-steel sheet with flanged edges and integral orifice ring with baked-enamel finish coat applied after assembly.

C. Steel Fan Wheels: Formed-steel blades riveted to heavy-gage steel spider bolted to cast-iron hub.

D. Fan Wheel: Replaceable, extruded-aluminum, airfoil blades fastened to cast-aluminum hub; factory set pitch angle of blades.

E. Fan Drive: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing.

F. Accessories:

1. Gravity Shutters: Aluminum blades in aluminum frame; interlocked blades with nylon bearings.

2. Motor-Side Back Guard: Galvanized steel, complying with OSHA specifications, removable for maintenance.

3. Wall Sleeve: Galvanized steel to match fan and accessory size.

4. Weathershield Hood: Galvanized steel to match fan and accessory size.

5. Weathershield Front Guard: Galvanized steel with expanded metal screen.

6. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.

7. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.

G. Capacities and Characteristics:
   1. Refer to Schedule on Plans.
   2. Vibration Isolators:
      a. Type: Elastomeric hangers
      b. Static Deflection: 1 inch.
   3. Spark Arrestance Class: C.

2.3 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.

B. Enclosure Type: Totally enclosed, fan cooled.

2.4 SOURCE QUALITY CONTROL

A. Certify sound-power level ratings according to AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating." Label fans with the AMCA-Certified Ratings Seal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install power ventilators level and plumb.

B. Ceiling Units: Suspend units from structure; use steel wire or metal straps.

C. Install units with clearances for service and maintenance.

D. Label units according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

3.2 CONNECTIONS

A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."

B. Install ducts adjacent to power ventilators to allow service and maintenance.

C. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:
   1. Verify that shipping, blocking, and bracing are removed.
   2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
   3. Verify that cleaning and adjusting are complete.
   4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
   5. Adjust belt tension.
   6. Adjust damper linkages for proper damper operation.
   7. Verify lubrication for bearings and other moving parts.
   8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
   9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
   10. Shut unit down and reconnect automatic temperature-control operators.
   11. Remove and replace malfunctioning units and retest as specified above.

C. Test and adjust controls and safety. Replace damaged and malfunctioning controls and equipment.

D. Prepare test and inspection reports.

3.4 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Comply with requirements in Section 230593 "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.

END OF SECTION 233423

SECTION 233713 - DIFFUSERS, REGISTERS AND GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Rectangular and square ceiling diffusers.
2. Louver face diffusers.
3. Linear slot diffusers.
4. Linear slot/bar grille diffuser plenums.
5. Registers and grilles.
6. Registers and grilles.
7. Linear bar grilles (floor mounted).

B. Related Sections:
1. Section 233300 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated, include the following:
1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.
3. Submit finish to the Architect for selection/approval for all new devices.

B. Refer to Section 230500 "Common Work Results for HVAC."

PART 2 - PRODUCTS

2.1 AIR DISTRIBUTION DEVICES

A. Furnish and install air distribution devices, mounted grilles, registers, diffusers, slot diffusers and bar diffusers as indicated on the Drawings. Provide mounting frames as required to accommodate the type of ceiling or surface in which the air distribution devices are to be mounted. The type, style, materials of construction, finish, face size, neck size, neck configuration, air pattern, and accessories shall be as indicated on the Drawings. Provide volume control damper for all ceiling diffusers, slot diffusers, bar diffusers, and exhaust registers.

B. All nominal 24" x 24" ceiling diffusers shall be provided with R-6, factory installed, moulded insulation blanket with foil skrim kraft vapor barrier. Insulation shall be applied to the back (top) of the diffusers.

2.2 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, including floor return grilles.

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.

D. Insulate linear device plenums as specified for ductwork in Section 230700 "HVAC Insulation" of these specifications.

3.3 ADJUSTING

A. After installation (new and existing), adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713

SECTION 235523 - PROPANE-FIRED RADIANT 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.

B. Reference to specification section 230510 for additional requirements.

1.2 SUMMARY

A. This Section includes propane-fired, tubular infrared radiant heaters.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of propane-fired radiant heater indicated. Include rated capacities, operating characteristics, and accessories.

B. Shop Drawings: For propane-fired radiant heaters. Include plans, elevations, sections, details, and attachments to other work.
1. Prepared by or under the supervision of a qualified professional engineer detailing fabrication and assembly of propane-fired radiant heaters, as well as procedures and diagrams.
2. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.
3. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
4. Wiring Diagrams: Power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

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

1. Structural members to which equipment will be attached.
2. Items penetrating roof and the following:
   a. Vent and propane piping rough-ins and connections.
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.

B. Field quality-control test reports.

C. Warranty: Special warranty specified in this Section.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For propane-fired radiant heaters to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Burner Igniters: Two (2) hot-surface burner igniter(s) for each style of propane-fired radiant heater furnished.

1.7 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of propane-fired radiant heater that fails in materials or workmanship within specified warranty period.
   1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 TUBULAR INFRARED HEATERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
   1. Reznor/Thomas & Betts Corporation.
   2. Roberts-Gordon, Inc.
   3. Schwank Inc.
   4. Sterling HVAC Products; Div. of Mestek Technology Inc.

B. Description: Factory assembled, piped, and wired, and complying with ANSI Z83.20/CSA 2.34.

C. Fuel Type: Design burner for propane having characteristics same as those of propane available at Project site.

D. Combustion Tubing: 4-inch- diameter steel with high-emissivity, high-temperature, corrosion-resistant external finish.

E. Tubing Connections: Stainless-steel couplings or flared joints with stainless-steel draw bolts.

F. Reflector: Polished aluminum, 97 percent minimum reflectivity, with end caps. Shape to control radiation from tubing for uniform intensity at floor level with 100 percent cutoff above centerline of tubing. Provide for rotating reflector or heater around a horizontal axis for minimum 45-degree tilt from vertical.

1. Reflector Extension Shields: Same material as reflectors, arranged for fixed connection to lower reflector lip and rigid support to provide 100 percent cutoff of direct radiation from tubing at angles greater than 45 degrees from vertical.
2. Include hanger kit.

G. Burner Safety Controls:
1. Gas Control Valve: Single-stage, regulated redundant 24-V ac gas valve containing pilot solenoid valve, electric gas valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff all in one body.
2. Blocked Vent Safety: Differential pressure switch in burner safety circuit to stop burner operation with high discharge or suction pressure.
3. Control Panel Interlock: Stops burner if panel is open.
4. Indicator Lights: Burner-on indicator light.

H. Burner and Emitter Type: Gravity-vented power burner, with the following features:
1. Emitter Tube: 4-inch- diameter, aluminized steel tubing with sight glass for burner and pilot flame observation.
2. Venting: Connector at exit end of emitter tubing for vent-pipe connection
   a. Vent Terminal: Vertical or Horizontal.
   b. Vent Cap: Stainless Steel
3. Burner/Ignition: Power gas burner with electronic spark and electronic flame safety.
4. Combustion-Air Connection: Duct connection for combustion air to be drawn directly from outdoors by burner fan.

I. Capacities and Characteristics: Refer to schedule on drawings

2.2 CONTROLS

A. Thermostat: 2-stage, wall-mounting type with 50 to 90 deg F operating range and fan on switch.
1. Control Transformer: Integrally mounted.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install and connect propane-fired radiant heaters and associated fuel and vent features and systems according to NFPA 54, applicable local codes and regulations, and manufacturer's written installation instructions.

B. Suspended Units: Suspend from substrate using chain hanger kits and building attachments.
1. Spring hangers are specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment"

C. Maintain manufacturers' recommended clearances to combustibles.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to propane-fired radiant heaters to allow service and maintenance.

C. Gas Piping: Comply with Section 221120 “Facility Propane Gas Piping". Connect gas piping to gas train inlet; provide union with enough clearance for burner removal and service.

D. Vent Connections: Comply with applicable code and manufacturer's requirements.

E. Electrical Connections: Comply with applicable requirements in electrical Sections.
1. Install electrical devices furnished with heaters but not specified to be factory mounted.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:
1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
2. Verify bearing lubrication.
3. Verify proper motor rotation.
4. Test Reports: Prepare a written report to record the following:
   a. Test procedures used.
   b. Test results that comply with requirements.
   c. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

C. Remove and replace malfunctioning units and retest as specified above.

3.4 ADJUSTING

A. Adjust initial temperature set points.

B. Adjust burner and other unit components for optimum heating performance and efficiency.

3.5 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain propane-fired radiant heaters. Refer to Section 017900 "Demonstration and Training."

END OF SECTION 235523

SECTION 238126 - SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Wiring Diagrams: For power, signal, and control wiring.

C. Samples for Initial Selection: For units with factory-applied color finishes.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Filters: 200 set(s) for each air-handling unit.
   2. Gaskets: One set(s) for each access door.
   3. Fan Belts: One set(s) for each air-handling unit fan.

1.7 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE Compliance:
1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - " Procedures," and Section 7 - "Construction and System Start-up."

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

1.8 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete."

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.
1. Warranty Period:
a. For Compressor: Five year(s) from date of Substantial Completion.
b. For Parts: Five year(s) from date of Substantial Completion.
c. For Labor: One year(s) 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. Carrier
2. Lennox
3. Daikin/McQuay/Goodman
4. JCI/York

2.2 INDOOR UNITS

A. Concealed Evaporator-Fan Components:
1. If one-side maintenance access is indicated on drawings, all components potentially requiring maintenance shall be fully accessible from one side and shall not require access from any other side. Such components shall include but are not limited to: filter, fan motor, fan, electrical connection(s), refrigerant piping connection, water piping connection, condensate drain connection, control panel, and controls hardware. If not indicated as one-side maintenance access, all maintenance shall be via sides shown as accessible on drawings.

2. Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.
3. Insulation: Faced, glass-fiber duct liner.
4. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 210/240.
5. Water Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 12 per inch, leak tested to 300 psig underwater; with a two-position control valve.
6. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements; with refractory ceramic support bushings, automatic-reset thermal cutout, built-in magnetic contactors, manual-reset thermal cutout, airflow proving device, and one-time fuses in terminal box for overcurrent protection.
7. Fan: Forward-curved, double-width wheel of galvanized steel; directly connected to motor.
8. Fan Motors:
   a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
   b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
   c. Wiring Terminations: Connect motor to chassis wiring with plug connection.
9. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
10. Filters: As scheduled.
11. Condensate Drain Pans:
    a. Fabricated with one percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.
       1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
       2) Depth: A minimum of 2 inches deep.
    b. Single-wall, stainless-steel sheet.
    c. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.
       1) Minimum Connection Size: NPS 1.
    d. Pan-Top Surface Coating: Asphaltic waterproofing compound.
    e. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.

2.3 OUTDOOR UNITS 5 TONS OR LESS

A. Air-Cooled, Compressor-Condenser Components:
   1. 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.
   2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
      a. Compressor Type: Scroll.

b. Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
c. Refrigerant Charge: R-410A.
d. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 210/240.

3. Heat-Pump Components: Reversing valve and low-temperature-air cutoff thermostat.
4. Fan: Aluminum-propeller type, directly connected to motor.
5. Motor: Permanently lubricated, with integral thermal-overload protection.
6. Low Ambient Kit: Permits operation down to 45 deg F (7 deg C).
7. Mounting Base: Polyethylene.

2.4 OUTDOOR UNITS (6 TONS OR MORE)

A. Air-Cooled, Compressor-Condenser Components:
1. 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.
2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
a. Compressor Type: Scroll.
b. Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
c. Refrigerant Charge: R-410A.
d. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 210/240.
3. Heat-Pump Components: Reversing valve and low-temperature-air cutoff thermostat.
4. Fan: Aluminum-propeller type, directly connected to motor.
5. Motor: Permanently lubricated, with integral thermal-overload protection.
6. Low Ambient Kit: Permits operation down to 45 deg F (7 deg C).
7. Mounting Base: Polyethylene.

2.5 ACCESSORIES

A. Control equipment and sequence of operation are specified in Section 230900A "Instrumentation and Control for HVAC – BacNet Controls Network."

B. Thermostat: Low voltage with subbase to control compressor and evaporator fan.

C. Thermostat: Wireless infrared functioning to remotely control compressor and evaporator fan, with the following features:

1. Compressor time delay.
2. 24-hour time control of system stop and start.
3. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.
4. Fan-speed selection including auto setting.

D. Automatic-reset timer to prevent rapid cycling of compressor.

E. 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.

F. Drain Hose: For condensate.

2.6 CAPACITIES AND CHARACTERISTICS

A. Refer to Schedule on Plans.

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-mounted, 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 Section 033000 "Cast-in-Place Concrete." Coordinate anchor installation with concrete base.

D. Install ground-mounted, compressor-condenser components on polyethylene mounting base.

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

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.
1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:
1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

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.

END OF SECTION 238126

SECTION 238127 - AIR COOLED DUCTLESS MINI-SPLIT SYSTEM

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Factory Built Ductless Mini-Split System Heat Pump Units.

B. Controls.

1.2 SUBMITTALS

A. Submit manufacturer's product data including:
   1. Dimensional data.
   2. Cross plot of condenser with its associated evaporator showing sensible and total capacities at scheduled design conditions.
   3. Electrical power and control wiring diagrams.
   4. Electrical characteristics.
   5. Installation instructions.
   6. Piping connection location and sizes.
   7. Maintenance and operating manuals.

1.3 QUALITY CONTROL

A. Conform to requirements of UL and applicable codes.

B. Test and rate cooling systems to ARI Standard 210.

C. Test and rate sound of Outdoor Unitary Equipment to ARI-270.

1.4 WARRANTY

A. Provide a warranty covering all parts and labor for one (1) year from date of start-up. Compressors shall have minimum warranty of five (5) years from date of start-up.

1.5 REGULATORY REQUIREMENTS

A. Conform to NFPA 70 National Electrical Code.

B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories, Inc., testing firm acceptable to the Authority Having Jurisdiction as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Daikin

B. Trane

C. Mitsubishi Electric.

2.2 TYPE AND PERFORMANCE

A. Provide self-contained, packaged, factory assembled and pre-wired ductless split system heat pump unit and Tru Wall Air conditioners consisting of an evaporator/blower unit, outdoor condensing unit and controls, and backup electric resistance heating coil. For through the wall units the evaporator and the compressor condenser units shall be in one cabinet.

B. The condensing unit and associated evaporator/blower unit shall be the product of one (1) Manufacturer and shall meet or exceed the capacity scheduled on the drawings. Ratings shall be in accordance with ARI 210/240 and ANSI/UL 207 and ANSI/UL 303. Testing shall be in accordance with ASHRAE Standard 14. Seasonal Energy Efficiency Rating (SEER) and Coefficient of Performance (COP) not less than prescribed by ANSI/ASHRAE 90A.

2.3 MATERIALS

A. Use corrosion resistant materials for parts in contact with refrigerant.

B. Provide timer circuits to prevent rapid loading and unloading of compressor.

2.4 CONDENSING UNIT

A. Cabinet:
1. Fabricated of G60 galvannealed steel, painted manufacturer's standard color.
2. Finished with corrosion inhibiting polyester powder coated paint.

B. Compressor:
1. Hermetically sealed, high efficiency rotary or reciprocating type depending on unit capacity.
2. Motor shall be PSC with internal overload protection.
3. Compressor shall be installed on resilient mountings.
4. Provide crankcase heater.

C. Condenser Coil: Seamless copper tubing arranged in a staggered configuration and mechanically expanded into enhanced aluminum fins.

D. Fan: Vertical discharge, direct drive, propeller fan resiliently mounted with fan guard on discharge.

E. Motors: Totally enclosed, 8 pole, PSC motor with built-in thermal overload protection.

2.5 CONTROLS

A. Provide 24 Volt control transformer and relays for 24V remote thermostat.

B. Provide relays and connection for remote condensing unit.

C. For each condensing unit, provide the following factory applied controls/components:

1. Compressor and Fan Motor Contactor.
2. Capacitor.
3. Loss of charge switch.
4. Low Voltage Transformer.
5. Low Voltage Terminals for interconnection with evaporator.
6. High Pressure Control on 18,000 BTU/h and larger sizes.
7. Large Capacity Suction Accumulator.
8. Defrost Control Board.
9. Defrost Termination Switch.

D. Provide a four-way, reversing valve, solenoid activated by 24V which shall be energized for cooling operation. A TXV with internal check valve shall provide operation through all temperature ranges in heat pump mode.

E. Provide a loss of charge safety switch arranged so that operation will shut down unit and require manual reset.

F. Provide controls to permit cooling operation below 60 degrees F. ambient temperature.

G. Provide the following unit mounted operating controls:
1. Thermostat-post surge fan control.
2. Fan speed control.
3. Heat/Cool switch when applicable.
4. Digital setpoint and room temperature display.

2.6 EVAPORATOR/BLOWER UNIT

A. Cabinet:
1. Fabricated of cold roll steel, with structural stiffeners, painted manufacturer's standard color.
2. High impact plastic air inlet panel with stamped inlet grille.
3. Insulate air stream surfaces with closed cell foam.

B. Fan Motor:
1. Fan: Tangential type, directly mounted to the motor shaft.
2. Motor: PSC type with overload protection.

C. Evaporator Coil:
1. Direct expansion cooling coil of seamless copper or aluminum tubes arranged in a staggered configuration and expanded into enhanced aluminum fins tested to 460 PSIG.
2. Coil shall drain into galvanized steel drain pan with anti-corrosion coating.

D. Filter: Permanent electrostatic type, washable, user accessible.

2.7 REFRIGERANT CIRCUIT:

A. Provide unit with one (1) refrigerant circuit. Unit shall be delivered with pre-charged refrigerant for the condenser coil and evaporator. Charging of the field installed piping shall be provided by the Division 15 Contractor.

B. Unit refrigeration valves shall be solid brass for sweat connection.

C. Provide the following for each refrigerant circuit:
   1. Bi-flow solid core filter drier.
   2. Liquid line sight glass and moisture indicator.
   3. Expansion valve for maximum operating pressure, per manufacturer.
   4. Insulated suction line.
   5. Suction and liquid line service valves.
   6. Liquid line solenoid valve.
   7. Charging valve.
   8. Discharge line check valve.
   9. Compressor discharge service valve.
   10. Condenser pressure relief valve.
   11. Large capacity suction accumulator with surge baffles.

2.8 THRU THE WALL UNITS

A. Provide unit with Fan motors, Robust, commercial-grade and totally enclosed fan motors run at lower temperatures to prevent overheating, Non-rusting aluminum endplates, rifled copper tubing and slit fins: Greater surface area creates maximum heat exchange efficiency, heavy 20-gauge steel cabinet: Strong and durable, Solid sleeve top ,Insulated plenum, Entry Gard Kick-in protection, High-efficiency compressor- Mounted on large, vibration-absorbing grommets, thick rubber grommets, Motor mount with dual resilient rings, Solid steel blower wheel housing

B. Provide unit with one (1) refrigerant circuit. Unit shall be delivered with pre-charged refrigerant for the condenser coil and evaporator. Charging of the field installed piping shall be provided by the Division 15 Contractor.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install per strict compliance with manufacturer's written instructions.

B. Provide mechanical and electrical connections in accordance with manufacturer's installation instructions.

C. Furnish charge of refrigerant and oil.

3.2 START-UP AND TESTING

A. Supply initial charge of refrigerant and oil for each refrigeration system. Replace losses of oil or refrigerant prior to end of correction period.

B. Test entire refrigeration piping system for leaks and repair leaks.

C. Shut-down system if initial start-up and testing take place in winter and machines are to remain inoperative. Repeat start-up and testing operating at beginning of first cooling season.

D. Provide cooling season start-up and winter season shutdown for first year of operation.

END OF SECTION 238127

SECTION 238239 – UNIT HEATERS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Propeller unit heaters with electric-resistance heating coils.

1.3 DEFINITIONS

A. BAS: Building automation system.

B. CWP: Cold working pressure.

C. PTFE: Polytetrafluoroethylene plastic.

D. TFE: Tetrafluoroethylene plastic.

1.4 ACTION SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each product indicated.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Plans, elevations, sections, and details.
   2. Location and size of each field connection.
   3. Details of anchorages and attachments to structure and to supported equipment.
   4. Equipment schedules to include rated capacities, operating characteristics, furnished specialties, and accessories.
   5. Location and arrangement of piping valves and specialties.
   6. Location and arrangement of integral controls.
   7. Wiring Diagrams: Power, signal, and control wiring.

C. Samples for Initial Selection: Finish colors for units with factory-applied color finishes.

D. Samples for Verification: Finish colors for each type of cabinet unit heater and wall and ceiling heaters indicated with factory-applied color finishes.

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, based on input from installers of the items involved:
   1. Suspended ceiling components.
   2. Structural members to which unit heaters will be attached.
   3. Method of attaching hangers to building structure.
   4. Size and location of initial access modules for acoustical tile.
   5. Items penetrating finished ceiling, including the following:
      a. Lighting fixtures.
      b. Air outlets and inlets.
      c. Speakers.
      d. Sprinklers.
      e. Access panels.
   6. Perimeter moldings for exposed or partially exposed cabinets.

B. Manufacturer Seismic Qualification Certification: Submit certification that cabinet unit heaters, accessories, and components will withstand seismic forces defined in Section 230548 "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.

C. Field quality-control test reports.

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. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

PART 2 - PRODUCTS

2.1 PROPELLER UNIT HEATERS

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

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Engineered Air Ltd.
   2. McQuay International.
   3. Reznor
   4. Sterling

C. Description: An assembly including casing, coil, fan, and motor in vertical discharge configuration with adjustable discharge louvers.

D. Comply with UL 2021.

E. Comply with UL 823.

F. Cabinet: Removable panels for maintenance access to controls.

G. Cabinet Finish: Manufacturer's standard baked enamel applied to factory-assembled and -tested propeller unit heater before shipping.

H. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

I. Electric-Resistance Heating Elements: Nickel-chromium heating wire, free from expansion noise and 60-Hz hum, embedded in magnesium oxide refractory and sealed in steel or corrosion-resistant metallic sheath with fins no closer than 0.16 inch. Element ends shall be enclosed in terminal box. Fin surface temperature shall not exceed 550 deg F at any point during normal operation.
   1. Circuit Protection: One-time fuses in terminal box for overcurrent protection and limit controls for high-temperature protection of heaters.
   2. Wiring Terminations: Stainless-steel or corrosion-resistant material.

J. Fan: Propeller type with aluminum wheel directly mounted on motor shaft in the fan venturi.

K. Fan Motors: Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."
   1. Motor Type: Permanently lubricated, variable speed

L. Control Devices:
   1. Wall-mounting, variable fan-speed switch.
   2. Wall-mounting, thermostat.

M. Capacities and Characteristics - Refer to Schedules for Capacities.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for 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 level and plumb.

B. Suspend propeller unit heaters from structure with all-thread hanger rods and spring hangers. Hanger rods and attachments to structure are specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

C. Install wall-mounting thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.

D. Install new filters in each fan-coil unit within two weeks of Substantial Completion.

3.3 CONNECTIONS

A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including connections. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:
   1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
   3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

3.5 ADJUSTING

A. Adjust initial temperature set points.

B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain cabinet unit heaters. Refer to Section 017900 "Demonstration and Training."

END OF SECTION 238239

SECTION 260001 - BASIC REQUIREMENTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Drawings and Specifications
1. Division 26 specifications are written in imperative and streamlined format. This imperative language is directed to the Contractor. The word "shall be" shall be included by inference where a colon (:) is used within sentences and phrases.

C. Codes, Permits and Standards
1. Comply with the most recently revised versions of applicable laws, rules, regulations, and ordinances of federal, state, and local utilities and authorities.
2. Obtain all applicable permits, licenses and inspections and pay all fees charged by the above authorities.
3. Work shall comply with the local city codes and ordinances, the regulations of state authorities having lawful jurisdiction and the codes, statues and reference standards identified within these Specifications. None of the terms or provisions of the Drawings or specification shall be construed as waiving any of the rules, regulations or requirements of these authorities. In the event of conflict between the Contract Documents and the local enforcing authority, the latter shall rule.
4. Where alterations to and deviations from the Contract Documents are required to comply with interpretations of a Code Authority Having Jurisdiction (AHJ), report the requirements and secure approval before starting work. Contractor shall review any requested modifications with the Engineer and secure his approval before proceeding.
5. Where Contract Document requirements are in excess of Code requirements and are permitted under the Code, the Contract Documents shall govern.

1.2 DEFINITIONS & ABBREVIATIONS

A. Definitions
1. Contract Documents - Drawings and the project manual, including Specifications.
2. Install: to set in place in position for service.
3. Furnish: to supply.
4. Provide: to install and furnish.
5. City - When used in an otherwise non-specific reference anywhere in the Contract documents, City is defined to refer to the local municipal authority governing the project address or the City whose ETJ includes the project address.

B. Abbreviations
1. ANSI American National Standards Institute.
2. ASHRAE American Society of Heating, Refrigerating & Air-Conditioning Engineers
3. EIA Electronic Industry Association.

4. ETL Electrical Testing Laboratory.
5. ETJ Extra-Territorial Jurisdiction
6. FM Factory Mutual
7. IEEE Institute of Electrical and Electronics Engineers
8. IES Illuminating Engineering Society of North America
9. LPI Lightning Protection Institute.
10. NFPA National Fire Protection Association
11. NEC National Electric Code (NFPA-70)
12. NESC National Electric Safety Code
13. NECA National Electrical Contractor's Association
14. NEMA National Electrical Manufacturers Association
15. NETA InterNational Electrical Testing Association
16. NRTL Nationally Recognized Testing Laboratory
17. OSHA Occupational Safety Health Administration (US Department of Labor)
18. UL Underwriters Laboratories

1.3 SUMMARY ORGANIZATION

A. PART 1 of This Section Includes:
   1. Electrical Utilities and Service
   2. Electrical equipment coordination and installation.
   3. Submittal requirements.

B. PART 2 of This Section Includes:
   1. Substitution requirements.

C. PART 3 of This Section Includes:
   1. Common Requirements for Electrical Installation
   2. Electric wiring of motors and equipment
   3. Vibration Isolation
   4. Quality Assurance requirements.

1.4 ELECTRIC UTILITIES AND SERVICE

A. Utilities: The Contract Documents reflect the general location and routing of utilities required for this project. Visit the site, and coordinate and confirm the exact requirements for electrical services. Refer to Division 01.
   1. Temporary Services:
      a. Provide temporary electrical service and electric power distribution and temporary lighting throughout the construction site. Install and maintain in accordance with National Electrical Code and OSHA requirements. Contractor shall make arrangements with the serving utility for point of service for temporary electric service and pay costs for delivery to and use at the site.
      b. Existing electrical distributions systems at the site may be utilized for temporary construction power. Submit to the Owner in writing, documents identifying the locations and anticipated maximum demand at which power will be utilized, and obtain the Owner's approval, in writing, prior to connection and utilization.

1.5 ELECTRICAL EQUIPMENT COORDINATION AND INSTALLATION

A. General: Refer to Division 1 for general coordination requirements applicable to the entire work. It is recognized that the Contract Documents are diagrammatic in showing certain physical relationships which must be established within the electrical work, and in its interface with other work including utilities and mechanical work and that such establishment is the exclusive responsibility of the Contractor. The Drawings show diagrammatically the sizes and locations of the various conduit and raceway systems and equipment items and the sizes of the major interconnecting distribution, without showing exact details as to elevations, offsets, control lines, and installation details. All major feeders 1-1/2" diameter and over shall be shown on site and floor plans.

1. Arrange electrical work in a neat, plumb and straight well organized and workmanlike manner with services running parallel with primary lines of the building construction and with a minimum of 7' overhead clearance where possible. Maintain 4" clearance of other systems and 12" above ceiling.
2. The Contractor shall carefully lay out his work at the site to conform to the architectural and structural conditions, to avoid obstructions and to provide proper grading of lines. Exact locations of outlets, apparatus and connections thereto shall be determined by reference to detail Drawings, equipment Drawings, roughing-in Drawings, etc., by measurements at the building and in cooperation with other Contractors and in all cases shall be subject to the approval of the Engineer. Relocations necessitated by the conditions at the site or directed by the Engineer shall be made without any additional cost to the Owner or Engineer.
3. All conduit and boxes, except those in the various equipment rooms, in unfinished spaces or where specifically designated herein, or on the Drawings, shall be run concealed in furrings, plenums and chases. Wherever conditions exist which would cause any of these items to be exposed in finished spaces, the Contractor whose work is involved shall immediately call the situation to the attention of the Engineer and shall stop work in those areas until the Owner's Representative or General Contractor directs the resumption of the work. Submit for approval a Shop Drawing for any change in equipment placement, etc.
4. Equipment has been chosen to fit within the available space with all required Code and maintenance clearances and shall be installed as shown. Every effort has been made to also accommodate equipment of other approved manufacturers, however since equipment and access space requirements vary, the final responsibility for installation access and proper fit of substituted equipment rests with the Contractor with approval from Author by having jurisdiction.

B. Pre-installation planning: Coordinate arrangement, mounting, and support of electrical equipment as follows:

1. Allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
2. Provide access for disconnecting means and working space for equipment with minimum interference to adjacent equipment.
3. The equipment shall be arranged to facilitate service, maintenance, and repair or replacement of components and equipment.
4. Electrical equipment shall not be installed below piping or ductwork.
5. System interferences shall be handled by giving precedence to pipe lines which require a stated grade for proper operation. Where space requirements conflict, the following hierarchy of precedence shall, in general, be observed:
   a. Building lines
   b. Structural members

c. Piping and ductwork installed at required slope.
d. Supply Ductwork
e. Exhaust Ductwork
f. Cable Tray
g. Domestic water piping
h. Feeder conduit
i. Branch conduit
j. Cabling not installed in raceway or cable trays

6. Coordination submittal requirements
   a. Provide electrical room layouts, scaled to 1/4" = 1' - 0" for all rooms or spaces containing electrical distribution equipment. These shall be provided with the associated electrical distribution equipment submittals.
   b. Floor plans shall show dimensioned layout, required working clearances, and required area above and around switchgear where pipe and ducts are prohibited. Show switchgear layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

1.6 DRAWINGS AND SPECIFICATIONS

A. General: The Drawings are schematic in nature and indicate approximate locations of the electrical systems, equipment, fixtures, and devices, except where specific locations are noted and dimensioned on the Drawings. All items are shown to approximate scale with intent to depict how these items shall be integrated into the building. Locate all items by field measurements and in accordance with the Contract Documents. Cooperate with other trades to ensure project completion as indicated.

B. Location: Prior to locating electrical devices, light fixtures, and other items, obtain the Architect/ Engineer's approval as to exact location. Locations shall not be determined by scaling Drawings. Mount lighting fixtures and electrical devices at the heights directed by the Architect/Engineer. Where there is a question concerning the required location for items of electrical work, the Contractor shall submit a request for information to the Architect/Engineer requesting specific directions for locating the item. The contractor shall be responsible for costs of redoing work of trades necessitated by failure to comply with this requirement.
   1. All electrical devices, lighting fixtures, and other devices shall be referenced to coordinated, established data points and shall be located to present symmetrical arrangements with these points and to facilitate the proper arrangements of building construction details, acoustical tile panels and other building features with respect to the mechanical and electrical outlets and devices. Electrical devices, fixtures, and outlets shall be referenced to such features as wall and ceiling furrings, balanced border widths, masonry joints, etc. Outlets in acoustical tile shall occur symmetrically in tile joints or in the centers of whole tiles and the exact location of each outlet and the arrangements to be followed shall be acceptable to the Architect/Engineer. Outlets in wall tile or masonry construction shall occur symmetrically in the centers of whole tiles, bricks, or blocks and the exact location of each outlet and the arrangement to be followed shall be acceptable to the Architect/Engineer.
   2. The Drawings show diagrammatic locations of the various outlets and apparatus. Exact locations of these outlets and apparatus shall be determined by reference to the Architectural Drawings and to all detail Drawings, equipment Drawings, rough-in Drawings, etc., by measurements at the building, and in cooperation with the

other trades. The Owner and Architect/Engineer reserve the right to make any reasonable change in the location of any outlet or apparatus before installation, without additional cost to the Owner.

C. Specifications: The specifications are intended to supplement the Drawings and it is not in the scope of the specifications to mention any part of the work which the Drawings are competent to fully explain. Conversely, any part of the work which the specifications are competent to fully explain, may not be mentioned on the Drawings.

D. Disagreement: Disagreement between the Drawings or specifications or within the Drawings or specifications shall be estimated using the better quality or greater quantity of material or installation, and a request for information shall be made to the Engineer.

1.7 DISCREPANCIES

A. Clarification: Clarification shall be obtained before submitting a proposal for the Work under this Division as to discrepancies or omissions from the Contract Documents or questions as to the intent thereof.

B. Detailed Instructions: Should it appear that the work hereby intended to be done or any of the materials relative thereto, is not sufficiently detailed or explained in the Drawings or Specifications, then the Contractor shall submit a request for information to the Engineer for such further Drawings or explanations as may be necessary before proceeding, allowing a reasonable time for the Engineer to respond. The Contractor shall conform to this additional information as a part of the Contract without additional cost to the Owner or Engineer.

C. Interpretations: Should any doubt or question arise respecting the true meaning of Drawings or Specifications, reference shall be made to the Engineer, whose written decision shall be final and conclusive. Undocumented statements will not be accepted as an excuse for inferior work.

D. Contractor Agreement: Consideration will not be granted for misunderstanding of the amount of work to be performed. Submission of a bid conveys full Contractor agreement of the items and conditions specified, shown, scheduled, or required for completion of the project.

1.8 SUBMITTAL REQUIREMENTS

A. Provide all electrical shop drawing submittals at the same time.

B. Submittals shall be provided in binders and arranged in sequence by Specification section number. Provide submittals only for specification sections that list this requirement.
   1. Provide tabs for each section, labeled to match the associated specification. The page after each tab section shall contain a typed list of any exceptions that the Contractor is proposing.
   2. Each page of the submittal shall be a clear copy or scan, indicating items and options proposed for use in the project with a graphical arrow. Items included on a submittal page that are not proposed for use shall be deleted with a strike-through

or other acceptable method that clearly distinguishes the proposed from non-relevant information.

C. Subject to the requirements in Division 1, at the Contractor's option, submittals may be provided in PDF form.
   1. All format and informational requirements for submittals in binders apply to PDF submittals.
   2. Multiple files may be submitted; however, these must be organized into a consistent format.
   3. PDF submittal shall include a table of contents with page numbers listed for the beginning of each section.
   4. Additionally, the PDF shall be formatted to include tab or chapter shortcuts, labeled with the associated specification section. These shortcuts shall allow the reader to jump to a tab or chapter associated with beginning of each specification section with a single action.
   5. At the engineer's request, the contractor shall submit hard copy version in accordance with requirements outlined above.

D. Provide closeout submittals for all products used. Refer to the related specification section for additional requirements.
   1. Provide maintenance and warranty information with contact information for parts and service of equipment.

PART 2 - PRODUCTS

2.1 GENERAL MATERIALS AND EQUIPMENT REQUIREMENTS

A. Materials and equipment shall be new, of best grade and quality, and meet all requirements of the Contract Documents. Materials and equipment shall conform to National Electrical Code requirements and shall be listed by Underwriters Laboratories, Inc. (UL). UL listing will be accepted as evidence that the material or equipment conforms to the standards of that agency. In lieu of this listing, submit a statement from a nationally recognized testing agency, indicating that products have been tested in accordance with UL criteria and that the materials and equipment comply with Contract requirements.

B. Materials and equipment shall be standard catalog products of manufacturers regularly engaged in the manufacture of products conforming to these Specifications. Custom fabricated items shall be fully described using Drawings and technical data sufficient to demonstrate compliance with the Contract Documents.

2.2 SUBSTITUTIONS

A. Basis of Design - For products specified in part 2.1 of the associated specification section, as "Basis of Design", that term is herein defined as the standard level of product that is required for the project.
   1. The use of term Basis of Design in these specifications is intended to allow the Contractor to propose use of non-specified manufacturer's products, provided that the proposed substitute is of equal or greater construction material, workmanship, quality, performance, and manufacturer support. If the product's proposed

location is not concealed, aesthetic considerations are also considered as a significant factor.

2. During the bid process, the Engineer will not evaluate products and provide approval prior to the bid date on proposed substitute products. If the Contractor wishes to propose substitutions, the Engineer will evaluate the successful Contractor's proposed alternates during the submittal review process. The Engineer will take no exception to the use of individual products determined to be equal. That decision may be the result of consultation and input from other members of the design team. If a product is not determined to be equal, it will be rejected and another product that is equal to the basis of design shall be re-submitted by the Contractor. The Engineer will not evaluate more than two substitution attempts before the Contractor is required to submit the specified product.
3. If the Contractor proposes product substitutions that may not be equal to the specified product, and cost savings are associated with the use of the proposed substitute, then the Contractor should propose these as part of a VE (Value Engineering) process, with line item cost savings identified for each product substitution proposed. With information on line item costs, the design team may determine if the proposed substitutes, though not equal, represent a better value and these *may* be recommended for use.

B. Substitutions are generally not allowed for products specified in the associated specification section when listed as "Provide products by one of the following". If there is a concern about delivery schedules from the manufacturers listed or other factors, these special case substitutions will be considered individually during the submittal phase.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Workmanship: Work shall be executed, and materials installed in accordance with the best practice of the trades in a thorough, substantial, workmanlike manner by competent, state licensed workmen, presenting a neat appearance when completed, straight and plumb.

B. Manufacturer's Recommendations: With exceptions as specified or indicated on the Drawings or in the Specifications, apply, install, connect, erect, use, clean, and condition manufactured articles, materials, and equipment per manufacturer's current printed recommendations. Copies of such printed recommendations shall be kept at the job site and made available as required.

3.2 SPACE REQUIREMENTS

A. General: Determine in advance of purchase that the equipment and materials proposed for installation will fit into the confines indicated, leaving adequate code clearances for adjustments, repair, or replacement and comply with code.

B. Clearance: Allow adequate space for clearance in accordance with requirements of the Code and local inspection department.

C. Scheduled Equipment: The design shown on the Drawings is based on the equipment scheduled.

D. Responsibility: Space requirements and equipment arrangement may vary for each manufacturer, the responsibility for ensuring initial access and suitability rests with the Contractor.

E. Review: Final arrangements of equipment to be installed shall be subject to the Architect's review.

3.3 SAFETY REGULATIONS

A. All electrical work, including work associated with temporary power, shall be performed in compliance with all applicable and governing safety regulations. All safety lights, guards, signs, and other safety materials and provisions required for the performance of the electrical work shall be provided by and operated by the Electrical contractor.

3.4 DELIVERY, STORAGE AND HANDLING OF MATERIALS

A. General: Protect all materials and equipment to be installed under this Division from physical and weather damage.

B. Scope: Work under this Division shall include, but not limited to:
1. Shipping from point of manufacture to job site.
2. Unloading, moving, and storage on site with proper safeguards as required to properly protect equipment from corrosion, drip, humidity, dust, and physical damage.
3. Hoisting and scaffolding of materials and equipment included in this Division.
4. Ensuring safety of employees, materials, and equipment using such hoisting equipment and scaffolding.

C. Coordination: All large pieces of equipment which are to be installed in the building and which are too large to permit access through doorways, stairways or shafts shall be brought to the job by the Contractor and shall be placed in the spaces before enclosing partitions and structure are completed. Contractor shall support equipment above floor slab and provide suitable, protective covering.

D. Install in accordance with approved equipment submittal layouts.

E. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

F. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames." Coordinate location of access panels and doors with Architect prior to the associated equipment rough-in.

G. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping".

H. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

3.5 ELECTRIC WIRING OF MOTORS AND EQUIPMENT

A. The work of Division 26 includes:
1. Installation and power wiring of individually mounted motor controllers furnished under other Divisions.
2. Power wiring for individually mounted and group mounted motor controllers furnished and installed under Division 26.
3. Power wiring of motor controllers provided integral with equipment furnished under Division 26 and other Divisions.
4. Power and control wiring, of any voltage, of systems specified in Division 26.

B. The work of Division 26 does not include:
1. Control wiring associated with HVAC/EMCS control systems, including that which interface with fire detection and alarm systems, and motor control.
2. Remote control devices associated with HVAC/EMCS controller systems which interface with and execute control of motor control equipment.

3.6 VIBRATION ISOLATION

A. General: Warrant the electrical systems, and their component parts to operate without objectionable noise or vibration. Noise from systems or equipment which results in noise within occupied spaces above the recommended NC curves (refer to ASHRAE Standard) shall be considered objectionable. Vibration shall not be apparent to the senses in occupied areas of the building. Objectionable noise, vibration, or transmission thereof to the building shall be corrected.

B. Provide vibration isolation means for equipment and materials to prevent the transmission of perceptible vibration, structure borne, or air borne noise. Items requiring vibration isolation include:
1. Switchgear, motor control centers, motor starter panelboards, motors, transformers and rotating and reciprocating equipment shall be mounted on cork, rubber or steel spring isolator units properly sized, spaced and loaded as recommended by manufacturer.
2. Electrical Conduit: Isolate from dry type transformers, rotating and reciprocating machinery using flexible conduit, 18" minimum length or 12" of flexible conduit per 1" of conduit diameter with maximum of 36".

3.7 QUALITY ASSURANCE TESTING

A. Description of Work
1. General: Provide testing of electrical work installed under Divisions 26 and 28, as specified herein and in other Division 26, 27 and 28 sections. Feeders and equipment shall not be placed in service until they have been checked out and tested, as applicable.

B. Personnel

1. Personnel: Submit evidence to show that the personnel who will actually test the systems are qualified and state certified.
2. The Engineer/Owner reserves the right to request that the originally approved personnel be replaced with other qualified personnel if, in his opinion, the original personnel are not qualified or are not properly conducting the system testing.

C. Submittals
1. Testing Procedures: Submit four copies of all proposed testing procedures to the Engineer for review at least 30 days prior to conducting any testing.
2. Reporting Forms: Submit four copies of proposed forms to be used in recording testing data and results to the Engineer for review at least 30 days prior to conducting any testing on the project.
3. Test Data and Results: Submit four copies of complete data and certified test results for each test performed, including, but not limited to:
   a. Test performed.
   b. Test procedure.
   c. System and area tested.
   d. Date(s) and time(s) of test.
   e. Weather conditions.
   f. Test criteria.
   g. Test results.
   h. Additional pertinent information.
4. Operational Certification: Submit four certified copies of an operational certification which documents that all equipment and systems have been fully tested to verify proper operation in accordance with the design shown in the Construction Documents and manufacturer's recommendations.
5. Certification: Certifications stating that submitted test data and results are true and correct shall be provided for all submittals under this Section. Certification shall be executed by an authorized officer if the Contractor is a corporation, by a partner if the Contractor is a partnership, by the Owner if the Contractor is a sole proprietorship or by the authorized representative if the Contractor is a joint venture.
6. Calibration List: Submit four copies of a listing of testing devices to be used for the project to the Engineer for approval. Listing shall include documentation that devices are properly and currently calibrated.
7. Prepare test and inspection reports, including a certified report that identifies electrical distribution equipment included and that describes scan results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
8. Test Log: The Contractor shall maintain a test log at the site to document the results of all successful and unsuccessful testing as it is performed. This log shall be available for review by the Engineer and a copy of the log shall be submitted to the Engineer and Owner's Representative prior to the Substantial Completion inspection. A space shall be provided on the test log for signoff by the Owner's Representative.

D. Notice
1. General: Notify the Engineer and the Owner's Representative in writing two weeks prior all scheduled testing to allow time for scheduling witness of testing, where elected by the Engineer and Owner's Representative.

E. Materials
1. General: Provide all materials and test equipment required for testing specified electrical systems, including retesting until acceptable test results are obtained.

F. Manufacturer's Field Service
1. Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections, and to assist in testing.

G. Preparation
1. Perform visual mechanical inspection and electrical tests for field connections Test insulation resistance for each electrical distribution equipment bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

H. Testing
1. General: Tests shall be made during the course of construction as specified and as required by authorities having jurisdiction. Such tests shall be conducted by this Division as a part of the Work and shall include all personnel, material, and equipment required to perform tests until satisfactory results are obtained. Any defects detected during testing shall be satisfactorily repaired or the equipment involved shall be replaced and the tests re-executed.
2. Tests: Refer to the Table below for inspection and testing requirements associated with listed product specification sections:

Spec Section #	Title	Inspect connections	Torque connections	Test Continuity	Insulation resistance	Thermographic scan	Voltage to Gnd @ at termi-	Notes
260519	**LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES**	○		○	○			
260526	**GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS**	○	○	○			○	
262416	**PANELBOARDS**	○	○	○	○	○		
263213	**ENGINE GENERATORS**	○	○	○				a
263600	**TRANSFER SWITCHES**							a

Note a: Refer to individual specification section for additional testing requirements.

3.8 CONTRACTOR WARRANTIES AND GUARANTEES

A. General: Contractor shall guarantee all material and equipment installed by him against defects in workmanship and material for a period of 24 months after final acceptance of the work by the Owner and he shall repair or replace any materials or equipment developing such defects within that time, promptly on due notice given him by the Owner and at Contractor's sole cost and expense.

B. Equipment: All equipment bearing a manufacturer's guarantee in excess of the time requirement above, such as electrical equipment, devices, components, and similar items, shall be considered to have that guarantee extended directly to the Owner by the manufacturer. Any such equipment that proves defective in materials or workmanship within the guarantee period is to be corrected by the Contractor in accordance with the manufacturer's guarantee.

C. Start-up: The Electrical Contractor shall provide instructions and equipment starting service on new equipment for two complete years after date of final acceptance of the work by the Owner, at Contractor's sole cost and expense.

END OF SECTION 260001

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
   1. Building wires and cables rated 600 V and less.
   2. Connectors, splices, and terminations rated 600 V and less.

1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. NBR: Acrylonitrile-butadiene rubber.

C. MC: Metal Clad Cable, Type MC, Reference NEC Article 330

1.4 SUBMITTALS

A. Shop Drawing submittals shall include, but not be limited to, the following:
   1. The Contractor shall submit to the Engineer for review a list of the proposed manufacturers of wire and cable, cable lugs, cable connectors and termination fittings listed herein. The Contractor may install wire and cable, cable lugs, cable connectors and termination fittings furnished by any manufacturer listed on the approved submittal.
   2. Cut sheets on all 300 and 600 volt conductors with manufacturers name, ratings and capacities, insulation characteristics, and available colors, clearly listed.
   3. Cut sheets indicating all cable lugs, termination fittings and cable connectors.

B. Closeout Submittal
   1. Include final version of approved shop drawing submittals within the Operation and Maintenance manual.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. General Cable Corporation
   2. Senator Wire & Cable Company
   3. Southwire Company

4. Cerrowire
5. Philatron

B. Copper Conductors: Comply with NEMA WC 70.

C. Conductor Insulation: Comply with NEMA WC 70 for Types THW, THHN-THWN and XHHW.

D. Multi-conductor Cable: Comply with NEMA WC 70 for metal-clad cable, Type MC with ground wire.

2.2 CONNECTORS AND SPLICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. AFC Cable Systems, Inc.
2. Hubbell Power Systems, Inc.
3. O-Z/Gedney; EGS Electrical Group LLC.
4. 3M; Electrical Products Division.
5. TE Connectivity
6. Polaris Electrical Connectors

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type THHN-THWN, single conductors in raceway or Type XHHW, single conductors in raceway.

B. Exposed Feeders: Type THHN-THWN, single conductors in raceway.

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN-THWN, single conductors in raceway.

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.

E. Feeders Installed below Raised Flooring: Type THHN-THWN, single conductors in raceway.

F. Exposed Branch Circuits, Including in Crawlspaces: Type THHN-THWN, single conductors in raceway.

G. Branch Circuits Concealed in Ceilings, Walls, and Partitions:
1. Type THHN-THWN, single conductors in raceway.
2. Where otherwise allowed in the Construction Documents and NEC, MC cable may be used, subject to constraints listed in 3.3, H., hereinbelow.

H. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.

I. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

J. Class 1 Control Circuits: Type THHN-THWN, in raceway.

K. Class 2 Control Circuits: Type THHN-THWN, in raceway or Power-limited cable, concealed in building finishes.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.

E. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."

F. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."

G. Provide support for conductors in vertical raceways in accordance with NEC 300.19. Refer to Table 300.19(A) for support spacing distance requirements of specific cable sizes.

H. The use of Metal-Clad (MC) cable is prohibited except as follows:
1. Limit the use of Type MC cable to single-phase branch circuits in interior dry locations, supplying wall mounted devices.
2. Conceal Type MC cable above accessible ceilings, in drywall partitions, and in equipment enclosures.
3. No run of Type MC cable shall exceed 25'-0".

4. Do not run Type MC cable horizontally in walls.
5. Do not run Type MC cable directly into surface-mounted panels, cabinets or other equipment from switches or other devices.
6. Use of Type MC Cable for Receptacle Circuits
   a. The conduit between the panelboard and junction box and between junction boxes above the accessible ceiling in the room or space in which the receptacles are located shall be rigid metal conduit (RMC), intermediate metal conduit (IMC), or EMT. Type MC cable is not permitted for this application.
   b. No more than three (3) single-phase receptacle circuits shall be permitted in a single conduit for installations above the ceiling.
7. Use of Type MC Cable for Lighting Circuits:
   a. The conduit between the panelboard and junction box above the accessible ceiling in the room or space in which the lighting fixtures are located shall be RMC, IMC, or EMT. Type MC cable is not permitted for this application.
   b. The Owner's Field Inspector may provide different directions or requirements to the contractor depending on actual field conditions or other considerations.
   c. Type MC cable may be run vertically in the wall for a length not to exceed 25'-0" between a junction box above the ceiling and each light switch.
   d. Type MC cable runs between a junction box above the ceiling and a lighting fixture shall not exceed 6'-0".
8. Prior to installation, the contractor shall submit to Engineer/Owner for review a plan or sketch of each space or room identifying where the use of type MC cable is proposed and how it is to be supported. MC cable shall be prohibited in these types of spaces if the ceilings are not accessible. Specify the length for each run of type mc cable on the plan or sketch.
9. Material for MC Cabling
   a. Type MC cable and connectors shall be UL 1569 listed.
   b. 600V THHN/THWN-insulated solid copper circuit conductors with an insulated copper equipment grounding conductor.
   c. Minimum conductor size #12 AWG; provide larger conductors as required to limit voltage drop 3 percent at full connected load and to adjust allowable ampacity if there are more than 3 current-carrying conductors in a cable.
   d. Conductor color code: Refer to Owner's Design Guidelines, "Low-Voltage Conductors."
   e. Listed insulated-throat or insulating-bushing connectors.
10. Installation
   a. Install Type MC cable according to NECA 120, Standard for Installing Armored Cable (AC) and Metal-Clad Cable (MC) (ANSI).
   b. Use listed spring steel Type MC cable supports or plastic tie wraps to support Type MC cables; do not use tie wire to support Type MC cables.

3.4 WIRING APPLICATION, SIZE AND DERATION

A. General –
   1. Provide individual neutrals for each branch circuit phase.

2. Provide conductor size equal or greater than as specified on the drawings. Where not specifically shown, minimum wire size shall be #10AWG copper for homeruns and #12 AWG copper for 20A branch circuits.

B. Apply ambient temperature deration factors per NEC 310.15 (B).

C. Apply adjustment factors for more than three current carrying conductors, where applicable, per NEC 310.15 (C). Homeruns shall not contain more than three branch circuits.

D. Unless specifically indicated on the drawings, conduits containing multiple homerun circuits to serve a wireway downstream of a panelboard is not allowed.

3.5 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings.

C. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches (300 mm) of slack.

3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.7 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Division 07 Section 078413 "Penetration Firestopping."

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:
1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.

END OF SECTION 260519

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DESCRIPTION OF WORK

A. Section includes general requirements for grounding and bonding of electrical installations, systems, and equipment.

1.3 SUBMITTALS

A. Shop Drawing submittals shall include, but not be limited to, the following:
   1. The Contractor shall submit to the Engineer for review a grounding system diagram for special grounding systems.
   2. Cut sheets of grounding products.

B. Closeout Submittal
   1. Include final version of approved shop drawing submittals within the Operation and Maintenance manual.

PART 2 - PRODUCTS

2.1 CONDUCTORS

A. Insulated Conductors: Copper or tinned-copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:
   1. Solid Conductors: ASTM B 3.
   2. Stranded Conductors: ASTM B 8.
   3. Tinned Conductors: ASTM B 33.
   4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch (6 mm) in diameter.
   5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
   6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
   7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

C. Bare Grounding Conductor and Conductor Protector for Wood Poles:
   1. No. 4 AWG minimum, soft-drawn copper.
   2. Conductor Protector: Half-round PVC or wood molding; if wood, use pressure-treated fir, cypress, or cedar.

D. Grounding Bus: Provide grounding busbars of size indicated on drawings. If not indicated, provide a pre-drilled, rectangular bar of annealed copper, 1/4 by 4 inches (6.3 by 100 mm) in cross section, with 9/32-inch (7.14-mm) holes spaced 1-1/8 inches (28 mm) apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5,000 V.

2.2 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, pressure type with at least two bolts.
   1. Pipe Connectors: Clamp type, sized for pipe.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

D. Bus-bar Connectors: Mechanical type, cast silicon bronze, solderless compression type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

2.3 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel 3/4 inch by 10 feet (19 mm by 3 m) in diameter.

B. Chemical-Enhanced Grounding Electrodes: Copper tube, straight or L-shaped, charged with non-hazardous, electrolytic chemical salts.
   1. Termination: Factory-attached No. 4/0 AWG bare conductor at least 48 inches (1200 mm) long.
   2. Backfill Material: Electrode manufacturer's recommended material.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

B. Underground Grounding Conductors: Install bare copper conductor, No. 2/0 AWG minimum.
   1. Bury at least 24 inches (600 mm) below grade.
   2. Duct-Bank Grounding Conductor: Bury 12 inches (300 mm) above duct bank when indicated as part of duct-bank installation.

C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.

D. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
   1. Install bus on insulated spacers 2 inches (50 mm) minimum from wall, 6 inches (150 mm) above finished floor unless otherwise indicated.
   2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down to specified height above floor; connect to horizontal bus.

E. Conductor Terminations and Connections:
   1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
   2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
   3. Connections to Ground Rods at Test Wells: Bolted connectors.
   4. Connections to Structural Steel: Welded connectors.

3.2 EQUIPMENT GROUNDING

A. Install bare grounding electrode conductors in raceway.
   1. Exterior applications – Raceways used for protection of the GEC in exterior applications shall be PVC SCH80.
   2. Provide bonding jumpers from the GEC to listed grounding fittings at each end of steel raceways, where used for protection of the GEC.

B. Install insulated equipment grounding conductors with all feeders and branch circuits.

C. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
   1. Feeders and branch circuits.
   2. Lighting circuits.
   3. Receptacle circuits.
   4. Single-phase motor and appliance branch circuits.
   5. Three-phase motor and appliance branch circuits.
   6. Flexible raceway runs.

D. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

E. Water Heater, Heat-Tracing, and Anti-frost Heating Cables: Install an insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

F. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

G. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a

nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

H. Telecommunications Equipment: In addition to grounding and bonding required by NFPA 70, provide an infrastructure grounding system compliant with requirements of ANSI/TIA-607-B-2011. The system shall have the following components, as relevant to building layout:

1. TMGB - (Telecommunications Main Grounding Busbar), located in the MDF or Main Telecommunications Equipment Room and connected to the building's grounding electrode system by means of a minimum 3/0 BCT (Bonding Conductor for Telecommunications).
2. TGB - (Telecommunications Grounding Busbar), located within each satellite Telecommunications Equipment Room or IDF, and connected to the TMGB via a TBB (Telecommunications Bonding Backbone). Provide TBB of the minimum size noted below unless larger size is indicated on the drawings.

TBB Conductor Length	TBB Minimum Size
Minimum	#4 AWG
21-26'	#3 AWG
27-33'	#2 AWG
34-41'	#1 AWG
42-52'	1/0
53-66'	2/0
67-84'	3/0
85-105'	4/0
Greater than 105'	250 kCM

3. GE - (Grounding Equalizer), provided between TGBs within satellite Telecommunications Equipment Rooms or IDFs at the top floor of multi-level buildings. The GE conductor shall be the same size as the largest TBB.
4. TEBC - (Telecommunications Equipment Bonding Conductor). Provide minimum #6 AWG conductor servings as TEBC from each metallic enclosure or equipment rack to the MTGB or TGB. Terminate the TEBC on a grounding terminal.

3.3 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor and install in conduit.

C. Ground Rods: Drive rods until tops are 2 inches (50 mm) below finished floor or final grade unless otherwise indicated.
   1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
   2. For grounding electrode system, install in accordance with details or description on drawing. If not otherwise indicated, provide at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

D. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
   1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
   2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
   3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

E. Grounding and Bonding for Piping:
   1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
   2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
   3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

3.4 LABELING

A. Comply with requirements in Section 260553 "Identification for Electrical Systems" for instruction signs. The label or its text shall be green.

B. Install labels at the telecommunications bonding conductor and grounding equalizer [and at the grounding electrode conductor where exposed].
   1. Label Text: "If this connector or cable is loose or if it must be removed for any reason, notify the facility manager."

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.

B. Tests and Inspections:
   1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
   2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
   3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at individual ground rods. Make tests at ground rods before any conductors are connected.
      a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
      b. Perform tests by fall-of-potential method according to IEEE 81.
   4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

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

D. Prepare test and inspection reports.

END OF SECTION 260526

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
   1. Provide materials specified in the associated drawing details, where shown.

1.2 DESCRIPTION OF WORK

A. This Section includes the following:
   1. Hangers and supports for electrical equipment and systems.
   2. Construction requirements for concrete bases.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. IMC: Intermediate metal conduit.

C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

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

1.5 ACTION SUBMITTALS

A. Product Data: For the following:
   1. Steel slotted support systems.
   2. Non-metallic slotted support systems.

B. Shop Drawings
   1. Provide shop drawings for fabricated assemblies, if required by the associated detail or if the assembly's proposed dimensions, construction materials, or supplementary information is different than shown on drawings.

1.6 QUALITY ASSURANCE

A. Comply with NFPA 70.

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified together with concrete Specifications.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 077200 "Roof Accessories."

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Allied Tube & Conduit.
      b. Cooper B-Line, Inc.; a division of Cooper Industries.
      c. ERICO International Corporation.
      d. GS Metals Corp.
      e. Thomas & Betts Corporation.
      f. Unistrut; Tyco International, Ltd.
      g. Wesanco, Inc.
   2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
   3. Non-metallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
   4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
   5. Channel Dimensions: Selected for applicable load criteria.

B. Non-metallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels, and angles with 9/16-inch- (14-mm-) diameter holes at a maximum of 8 inches (200 mm) o.c., in at least 1 surface.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Allied Tube & Conduit.
      b. Cooper B-Line, Inc.; a division of Cooper Industries.
      c. Fabco Plastics Wholesale Limited.
      d. Seasafe, Inc.
   2. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.
   3. Fitting and Accessory Materials: Same as channels and angles, except metal items may be stainless steel.
   4. Rated Strength: Selected to suit applicable load criteria.

C. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

D. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
   1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         1) Hilti Inc.
         2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
         3) MKT Fastening, LLC.
         4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
   2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated or stainless steel, for use in hardened Portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         1) Cooper B-Line, Inc.; a division of Cooper Industries.
         2) Empire Tool and Manufacturing Co., Inc.
         3) Hilti Inc.
         4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
         5) MKT Fastening, LLC.
   3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
   4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
   5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
   6. Toggle Bolts: All-steel, springhead type.
   7. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
   1. Secure raceways and cables to these supports with two-bolt conduit clamps.

D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.

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

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
   1. To Wood: Fasten with lag screws or through bolts.
   2. To New Concrete: Bolt to concrete inserts.
   3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
   4. To Existing Concrete: Expansion anchor fasteners.
   5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
   6. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
   7. To Light Steel: Sheet metal screws.
   8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction

boxes, transformers, and other devices on slotted-channel racks attached to substrate.

E. Drill holes for expansion anchor in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use minimum, 3000-psi (20.7-MPa), 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 033000 "Cast-in-Place Concrete" or Section 033053 "Miscellaneous Cast-in-Place Concrete."

C. Anchor equipment to concrete base.
1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

A. Touchup: 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 (0.05 mm).

B. Touchup: Comply with requirements in Section 099113 "Exterior Painting", Section 099123 "Interior Painting", and Section 099600 "High Performance Coatings" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 260529

SECTION 260533 – RACEWAYS, WIREWAYS AND BOXES

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.

B. Products shall be designed, manufactured, tested, and installed in compliance with the associated section of the NEC.

C. Products shall be used for purposes and installed in a manner consistent with the associated NRTL listing documentation.

D. Coordinate installation with related requirements in specifications:
   1. Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling"
   2. Section 260553 "Identification for Electrical Systems"

1.2 SUMMARY

A. Section Includes:
   1. Metal conduits, tubing, and fittings.
   2. Nonmetal conduits, tubing, and fittings.
   3. Metal wireways and auxiliary gutters.
   4. Surface raceways.
   5. Boxes, enclosures, and cabinets.
   6. Handholes and boxes for exterior underground cabling.

1.3 DEFINITIONS & ABREVIATIONS

A. ARC: Aluminum rigid conduit.

B. EMT ; Electrical Metallic Conduit

C. FMC: Flexible Metallic Conduit. Comply with UL 1; zinc-coated steel.

D. GRC, RGS: Galvanized rigid steel conduit. Comply with ANSI C80.1 and UL 6.

E. IMC: Intermediate metal conduit. Comply with ANSI C80.6 and UL 1242.

F. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360

G. RNC: Rigid Nonmetallic Conduit

H. ENT: Comply with NEMA TC 13 and UL 1653.

I. RNC: Type EPC-40-PVC or EPC-80-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.

J. LFNC: Comply with UL 1660.

K. Rigid HDPE: Comply with UL 651A.

L. Continuous HDPE: Comply with UL 651B.

M. Coilable HDPE: Preassembled with conductors or cables and complying with ASTM D 3485.

1.4 SUBMITTALS

A. Shop Drawing submittals shall include, but not be limited to, the following:
   1. Product Data:
      a. Data sheets shall be submitted only for products intended to be used, with highlighted text used to identify specific products proposed. Information that does not apply to the project shall be omitted from the submittal or crossed out.
   2. Shop Drawings:
      a. Provide outlined, dimensioned drawings for custom enclosures and cabinets. Include proposed construction materials, plans, elevations, sections, and attachment details.

B. Closeout Submittal
   1. Include final version of approved shop drawing submittals within the Operation and Maintenance manual.

PART 2 - PRODUCTS

2.1 METAL CONDUITS, TUBING, AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. Rigid Steel and Intermediate Metal Conduit:
      a. Allied Tube & Conduit; a Tyco International Company.
      b. Galvite/LTV Steel Tubular Products
      c. Republic Conduit
      d. Triangle PWC, Inc.
      e. Youngstown Sheet & Tube.
      f. Wheatland Tube Company; a division of Zekelman Industries.
   2. PVC-coated Rigid Steel:
      a. Allied Tube & Conduit; a Tyco International Ltd. Co.
      b. Flexi-Guard, Inc.
      c. Occidental Coating Company.
      d. Perma-Cote.
      e. Republic Conduit.
      f. Robroy.
      g. Triangle PWC, Inc.
      h. Youngstown Sheet & Tube.
      i. Wheatland Tube Company; a division of Zekelman Industries.

3. Electrical Metallic Tubing:
   a. Allied Tube Conduit; a Tyco International Ltd. Co.
   b. ETP Uni-Couple.
   c. Republic Conduit.
   d. Triangle PWC, Inc.
   e. Youngstown Sheet & Tube.
   f. Wheatland Tube Company; a division of Zekelman Industries.
4. Flexible Metal and Liquidtight Flexible Metal:
   a. AFC Cable Systems, Inc.
   b. Alflex
   c. Anaconda Metal Hose.
   d. Electri-Flex Company.
   e. Flexi-Guard, Inc.
   f. Triangle PWC, Inc.
   g. Wheatland Tube Company; a division of Zekelman Industries.
5. Raceway Fittings:
   a. Appleton Electric Company.
   b. Crouse Hinds.
   c. Efcor Division.
   d. ETP-Uni-Couple.
   e. O. Z/Gedney; a brand of EGS Electrical Group.
   f. Raco, Inc.
   g. Republic Conduit.
   h. Steel City.
   i. Thomas and Betts Corporation.

B. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. General:
   1. Provide metal conduit, tubing, and fittings of the type, grade, size, and weight (wall thickness) as shown and required for each service. Where type and grade are not indicated, provide proper selection determined by this Section to fulfill the wiring requirements and complying with the NEC for electrical raceways.
   2. For each electrical raceway system indicated, provide a complete assembly of conduit, tubing, or duct with fittings, including, but not necessarily limited to, connectors, nipples, couplings, expansion fittings, bushings, locknuts, other components and accessories as needed to form a complete system of the type indicated.
   3. Conduit fittings shall be designed and approved for the specific use intended. Conduit fittings, including flexible, shall have insulated throats or bushings. Rigid conduits shall have insulated bushings, except insulated throat grounding bushings shall be used & conduit where required by NEC Article 250.

D. Rigid Steel or Intermediate Metal Conduit: Rigid Steel shall be UL 6 and ANSI C80.1, hot-dipped galvanized steel. Intermediate Steel shall be UL 1242 and ANSI C80.6, hot-dipped galvanized steel. Both ends of conduits shall be threaded with factory-installed thread protectors. Couplings and fittings shall be threaded Type UL 6/and UL1242 and ANSI C80.1 and C80.6, hot dipped galvanized steel. Split type couplings and fittings is not acceptable. IMC conduit shall not be used in sizes larger than 4 inch. Expansion fittings shall be OZ Type "DX", Appleton Type "XJ", Crouse-Hinds Type "XC" or an

approved equal and shall have bonding jumpers. Cut ends shall be recoated with cold galvanized paint.

E. PVC Externally Coated Rigid Steel Conduit: Shall be ANSI C80.1 hot-dipped galvanized rigid steel conduit with an external 0.040 inch minimum PVC protective coating per NEMA Standard RN1. Both ends of conduit shall be threaded and thread protectors shall be factory-installed. Fittings shall be threaded type ANSI C80.4, hot-dipped galvanized with a 0.055 inch minimum PVC coating to match the conduit.

F. Electrical Metallic Tubing (EMT): Shall be UL 797 and ANSI C80.3 galvanized steel with plain ends.
1. The fittings, couplings and connectors shall be UL 797 and ANSI C80.4 galvanized steel type.
2. Fittings, couplings and connectors shall be all steel, compression type.
3. All EMT connectors shall have insulated throats or bushings.

G. Flexible Conduit:
1. Flexible Metal Conduit: UL 1, zinc-coated steel
2. Flexible Metal Conduit Fittings: UL 1, zinc-coated steel, insulated throat.

H. Liquid-tight Flexible Metal Conduit: UL360 Liquid-tight flexible metal conduit with liquid-tight jacket of flexible polyvinyl chloride (PVC) or neoprene.
1. Inner raceway shall be comprised of single strip, continuous, flexible, interlocked, double-wrapped [steel, galvanized inside and outside] [stainless steel] [aluminum]; forming a smooth internal wiring channel.

I. Liquid-tight Flexible Metal Conduit Fittings: UL 1, liquid-tight, zinc-coated steel, neoprene gaskets and O rings, insulated throat.

J. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS, TUBING, AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. Rigid Nonmetallic Conduit and Inner Duct:
   a. Carlon.
   b. Cantex, Inc.
   c. Triangle PWC, Inc.
2. Raceway Fittings:
   a. Cantex, Inc. (PVC).
   b. Carlon (PVC).

B. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Nonmetallic Conduit and Fittings:
1. Schedule 40 Rigid PVC Conduit: Per UL 651, and NEMA TC 2, 90oC conductor temperature rating, only encased in concrete duct bank.

2. Schedule 80 Rigid PVC Conduit: Per UL 651 and NEMA TC 2, 90oC conductor temperature rating not encased in concrete duct bank.

D. PVC Conduit Fittings: Per NEMA TC 3 and compatible with PVC conduit system.

E. Duct Bank Spacers: Spacers shall be interlocking plastic designed for the conduit sizes and nominal 3 inch spacing being used.

F. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

G. Fittings for LFNC: Comply with UL 514B.

H. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

I. Solvent cements and adhesive primers 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."

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following manufacturers:
1. Gutters and Wireways:
2. ABB.
3. Hoffman Manufacturing Company.
4. Square D Company.

B. Description: Sheet metal, complying with UL 870 and NEMA 250, with NEMA enclosure type as indicated on drawings. Where NEMA enclosure rating not indicated on drawings, provide the enclosure rating that meets or exceeds Code requirements and environmental exposure. Dimensional size shall exceed minimum requirements of NFPA 70.
1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Screw-cover type unless otherwise indicated.

E. Finish: Manufacturer's standard enamel finish.

2.4 SURFACE RACEWAYS

A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard enamel finish in color selected by Architect.
   1. Manufacturers: Subject to compliance with requirements, provide products by the following manufacturers:
      a. Mono-Systems, Inc.
      b. Panduit Corp.
      c. Wiremold / Legrand.

C. Surface Nonmetallic Raceways: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC with texture and color selected by Architect from manufacturer's standard colors, unless otherwise noted. Product shall comply with UL 94 V-0 requirements for self-extinguishing characteristics.
   1. Manufacturers: Subject to compliance with requirements, provide products by the following manufacturers:
      a. Hubbell Incorporated; Wiring Device-Kellems Division.
      b. Mono-Systems, Inc.
      c. Panduit Corp.
      d. Wiremold / Legrand.

2.6 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers: Subject to compliance with requirements, provide products by the following manufacturers:
   1. Interior Outlet Boxes:
      a. Appleton Electric Company.
      b. Bowers.
      c. O. Z./Gedney.
      d. National Electric Products Company.
      e. Raco; Hubbell
      f. Star Sheet Metal.
      g. Steel City; ABB Group.
   2. Weatherproof Outlet Boxes:
      a. Appleton Electric Company.
      b. Crouse-Hinds Company.
      c. Raco; Hubbell, Inc.
      d. Pyle-National Company.
      e. Red Dot.
   3. Junction and Pull Boxes:
      a. Appleton Electric Company.
      b. Arrow-Hart, Inc.
      c. O. Z. Gedney Company.
      d. Hoffman Engineering Company.
      e. Keystone Columbia, Inc.
      f. Square D Company.
      g. Unity.
   4. Cabinets:
      a. Hoffman Engineering Company
      b. Square D Company.
   5. Floor Boxes:
      a. Hubbell, Inc., Hubbell Wiring Systems.
      b. Steel City ABB Group.
      c. Legrand-Wiremold.

6. Fire-rated Poke-thru Boxes:
   a. Hubbell, Inc.; Hubbell Wiring Systems
   b. Steel City ABB Group.
   c. Legrand-Wiremold.
7. Conduit Bodies:
   a. Appleton Electric Company.
   b. Crouse-Hinds Company.
   c. Killark Electric Manufacturing Company.
   d. Pyle-National Company.
8. Bushings, Knockout Closures and Locknuts:
   a. Allen-Stevens Conduit Fittings Corporation.
   b. Allied Metal Stamping, Inc.
   c. Appleton Electric Company.
   d. Carr Company.
   e. Raco; Hubbell
   f. Steel City ABB Group.
   g. Thomas and Betts Company, Inc.

B. Types: The types of electrical boxes and fittings required for the project include, but are not limited to, the following:
   1. Outlet boxes.
   2. Junction boxes.
   3. Pull boxes.
   4. Cabinets.
   5. Floor boxes.
   6. Fire-rated poke-thru boxes.
   7. Conduit bodies.
   8. Bushings.
   9. Locknuts.

C. Interior Outlet Boxes: Provide galvanized steel interior outlet wiring boxes, of the type, shape, and size, including depth of box, to suit each respective location and installation; constructed with stamped knockouts in back and sides, and with threaded holes with screws for securing box covers or wiring devices. Provide "gang" boxes where devices are shown to be grouped.
   1. Type for Various Locations:
   2. Ceilings: 4 inches square, 2 1/8 inches deep.
      a. Standard Partitions, Where 1/2 inch and 3/4 inch Conduits are employed: 4 inch square by 2 1/8 inches deep boxes with one-gang or two-gang plaster covers shall be used.
      b. Thin Partitions Measuring 3 1/2 inches or less: 4 inch square by 2 1/8 inches deep boxes with one-gang or two-gang covers shall be used.
      c. Standard Partitions, Where Conduits of a Size Greater than 3/4 inch are employed: 4 11/16 inches square by 2 1/8 inches deep boxes with one-gang or two-gang plaster covers shall be used.
      d. Masonry Walls: Galvanized switch boxes made especially for masonry installations; depths of boxes must be properly coordinated for each specific installation.
      e. Poured Concrete: Provide plenum type boxes without any holes and with reset knockouts. Where extension rings are used to offset conduit between wall reinforcing steel, joint between extension ring and box shall be sealed to prevent concrete from entering box during pour.

f. Return Air Ceiling Plenum Boxes: In return air ceiling plenums, where 1/2 inch and 3/4 inch conduits are employed, 4 inches square by 2 1/8inches deep plenum boxes shall be used.
g. Surface: Type "FS" or Type "FD" box with surface cover.
h. Special: Where above types are not suitable, furnish boxes to suit the use taking into account space available, appearance, and Code requirements.

3. Switch Boxes:
a. One-gang/Two-gang Switch Boxes in Standard Walls or Partitions: If able to mount to stud, then 4 inch x4 inchx2 1/8 inches; if not, shall be 3 inches x 2 inches square corner boxes by 2 1/2 inches deep with appropriate mounting bracket for attachment to studs.
b. One-gang/Two-gang Switch Boxes in Thin Walls or Partitions: If able to mount to stud, then 4 inches x4 inches x1 1/2 inch, if not shall be 3 inches x 2 inches square corner boxes by 1 1/2 inches deep with appropriate mounting bracket for attachment to studs.
c. Three-gang and Up Switch Boxes in Standard Walls or Partitions: Shall be 4 1/2 inches wide solid gang boxes, with appropriate "gang" plaster covers as required.
d. Gangable boxes are prohibited.

4. Interior Outlet Box Accessories: Provide outlet box accessories as required for each installation, including proper covers or wall device plates, mounting brackets, wallboard hangers, extension rings, plaster rings for all boxes in plaster construction, fixture studs, cable clamps and metal straps for supporting outlet boxes, compatible with outlet boxes being used, and meeting requirements of individual wiring situations.

D. Weatherproof Outlet Boxes: Provide hot-dipped galvanized cast iron weatherproof outlet wiring boxes, of the type, shape, and size, including depth of box, with threaded conduit ends, cast metal cover plate with spring-hinged waterproof caps suitably configured for each application, including face plate gasket and corrosion resistant fasteners.

E. Junction and Pull Boxes: Provide galvanized sheet steel junction and pull boxes, with screw on covers and welded seams with stainless steel nuts, bolts, screws and washers, of the type, shape, and size, to suit each respective location and installation.
1. Type for Various Locations:
a. 100 Cubic Inches in Volume or Smaller: Standard outlet boxes with NO stamped knockouts.
b. 150 Cubic Inches in Volume or Larger: Code gauge steel with sides formed and welded, screw covers unless shown to have hinged doors. Hinged doors with locking device same as furnished on panelboards. Formed in field with a cutting tool to provide a clean symmetrically-cut hole.
c. Exterior or Wet Areas: Weatherproof galvanized or stainless steel construction with proper gaskets and corrosion resistant fasteners. A parking garage is considered a wet area.

F. Cabinets: Provide cabinets of size and style noted on the Drawings.
1. Cabinet fronts shall be steel. Other sheet metal for boxes shall be galvanized or stainless steel. Details of construction and methods of assembly shall meet the requirements of the Underwriters' Laboratories, Inc.

2. The panel doors of cabinets shall be provided with locks. Single panel doors of cabinets shall have a lock with ring pull. Single doors 48 inches or longer and pairs of doors shall have a lock with vertical bolt operation, 3 point locking. Locks shall be keyed alike. Two keys shall be supplied for each cabinet.
3. Cabinets shall have concealed hinges.
4. Flush-mounted trim shall be fastened to cabinet with adjustable trim clamps. Fasteners for cabinets in concealed areas shall be concealed, and cabinet doors shall be hinged type.
5. Each voice/data cabinet shall be equipped with 3/4 inch plywood backboard covering the entire inside rear surface and painted matte white with fire resistant paint.
6. Trims and doors shall have a suitable primer coat and a finish coat of the manufacturer's standard color.

G. Floor Boxes: Provide fully adjustable floor boxes for installation in concrete floors as indicated. Boxes shall be adjustable both before and after the concrete pour. Unless otherwise noted on the Drawings, provide the following:
1. Waterproof Membrane Floors - Flush Boxes: Concrete tight cast iron floor box with brass trim and service fittings to suit device shown and floor finish.
2. Non-waterproof Membrane Floors (Above Grade) - Flush Boxes: Concrete tight steel floor box with brass trim and service fittings to suit device shown and floor finish.

H. Fire-rated Poke-Thru Boxes: Fire-rated, UL listed poke thru boxes for installation through concrete slabs. Boxes shall be suitable for the slab thickness of the building and shall have UL listed abandon plates for use where boxes are removed. Provide poke-thru boxes to suit devices shown and as scheduled on the Drawings.

I. Conduit Bodies: Provide galvanized cast Malleable Iron Form 7, clip on gasket covers conduit bodies, of the type, shape and size, to suit each respective location and installation, constructed with threaded conduit ends, removable cover, and corrosion resistant screws.

J. Bushings, Knockout Closures, and Locknuts: Provide corrosion resistant no stamp knockouts, box knockout closures, conduit locknuts, gasketed locknuts, insulated conduit bushings and insulated grounding conduit bushings of the type and size to suit each respective use and installation.

2.7 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. General Requirements for Handholes and Boxes:
1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Manufacturers Subject to compliance with requirements, provide products by the following manufacturers:
1. Pre-Cast Concrete Handholes and Boxes
a. Carder Concrete Products.
b. Christy Concrete Products.
c. Elmhurst-Chicago Stone Co.

d. Oldcastle Precast Group.
e. Riverton Concrete Products; a division of Cretex Companies, Inc.
f. Utility Concrete Products, LLC.
g. Utility Vault Co.
h. Wausau Tile, Inc.

2. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.
   a. Armorcast Products Company.
   b. Carson Industries LLC.
   c. CDR Systems Corporation; Hubbell Power Systems.
   d. NewBasis.
   e. Oldcastle Precast, Inc.; Christy Concrete Products.
   f. Synertech Moulded Products; a division of Oldcastle Precast, Inc.
3. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with frame and covers of cast iron.
   a. Manufacturers: Subject to compliance with requirements, provide products by the following manufacturers:
      1) Armorcast Products Company.
      2) Carson Industries LLC.
      3) CDR Systems Corporation; Hubbell Power Systems.
      4) NewBasis.
      5) Nordic Fiberglass, Inc.
      6) Oldcastle Precast, Inc.; Christy Concrete Products.
      7) Synertech Moulded Products; a division of Oldcastle Precast, Inc.

C. Requirements:
1. Concrete Handholes and Boxes
   a. Comply with ASTM C 858 for design and manufacturing processes.
   b. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.
   c. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
   d. Cover Finish: Non-skid finish shall have a minimum coefficient of friction of 0.50.
   e. Cover Legend: Molded lettering, "ELECTRIC".
   f. Configuration: Units shall be designed for flush burial and have open bottom, unless otherwise indicated.
   g. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.
   h. Extension shall provide increased depth of 12 inches (300 mm) or as required for specific site conditions.
   i. Slab: Same dimensions as bottom of enclosure, and arranged to provide closure.
   j. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches (300 mm) vertically and horizontally to accommodate alignment variations.

k. Windows shall be located no less than 6 inches (150 mm) from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
l. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
m. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.
n. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
o. Type and size shall match fittings to duct or conduit to be terminated.
p. Fittings shall align with elevations of approaching ducts and be located near interior corners of handholes to facilitate racking of cable.
q. Handholes 12 inches wide by 24 inches long (300 mm wide by 600 mm long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

2. Handholes and Boxes other than Pre-cast concrete
a. Standard: Comply with SCTE 77.
b. Color: Gray
c. Configuration: Units shall be designed for flush burial and have open bottom, unless otherwise indicated.
d. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
e. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
f. Cover Legend: Molded lettering, "ELECTRIC."
g. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
h. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
i. Handholes 12 inches wide by 24 inches long (300 mm wide by 600 mm long) and larger shall have factory-installed inserts for cable racks and pulling-in irons.

D. Source Quality Control for Underground Enclosures
1. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
a. Tests of materials shall be performed by an independent testing agency.
b. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
c. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012 and traceable to NIST standards.

3.1 SOURCE QUALITY CONTROL

A. Test and inspect precast concrete utility structures according to ASTM C 1037.

B. Non-Concrete Handhold and Pull Box Prototype Test. Test prototypes of manholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied. Control.

C. Test of materials shall be performed by an independent testing agency.

D. Strength tests of complete boxes and covers shall be by either an independent testing agency or the manufacturer. A qualified registered professional engineer shall certify test by the manufacturer.

E. Testing machine pressure gauges shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.2 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
1. Exposed Conduit: GRC (GRS) or IMC or RNG, Type EPC-80-PVC. RNC conduit is not allowed on or above roofs.
2. Concealed Conduit, Aboveground: EMT.
3. Underground Conduit (Service entrance and feeders): Concrete encase RNG, Type EPC-40-PVC or Type EPC-80-PVC.
4. Underground Conduit (Branch Circuits): Type EPC-80-PVC, direct buried.
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic Electric Solenoid, or Motor Driven Equipment) LFMC
6. Boxes and Enclosures, Aboveground: NEMA 250 Type 3R

B. Indoors: Apply raceway products as specified below unless otherwise indicated:
1. Exposed, Not Subject to Physical Damage: EMT
2. Exposed, Not Subject to Severe Physical Damage (EMT)
3. Exposed and Subject to Severe Physical Damage (below 20 ft in elevation). GRC, (GRS) or IMC. Raceway locations include, but are not limited to, the following:
   a. Loading dock.
   b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
   c. Central Plants.
   d. Gymnasiums.
4. Concealed in Ceilings and Interior Walls and Partitions: EMT
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic Electric Solenoid, or Motor-Driven Equipment). FMC, except use LFMC in damp or wet locations.
6. Damp or Wet locations: GRC (GRS) or IMS.
7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.

C. Minimum Raceway Size: 3/4-inch (21-mm) trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.
1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise directed. Comply with NEMA FB 2.10.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks and scrapes in PVC coating after

installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.

3. EMT: Use compression, steel fittings. Comply with NEMA FB 2.10.
4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

E. Install surface raceways only where indicated on Drawings.

F. Do not install non-metallic conduit at roof applications or where ambient temperature exceeds 120 deg F (49 deg C).

3.3 INSTALLATION

A. General:
1. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
2. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot water pipes. Install horizontal raceways runs above water and steam piping.
3. Complete raceway installation before starting conductor installation.
4. Comply with requirements in Section 260529 – "Hangers and Supports for Electrical Systems: for hangers and supports.
5. Comply with requirements if 260553, "Identification for Electrical Systems" for applicable labeling, painting and nameplates.
6. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches (300 mm) of changes in direction.

B. Installation of raceways above ground:
1. Conceal conduit and EMT within finished walls, ceilings and floors unless otherwise indicated.
2. Install above grade conduits parallel or perpendicular to building lines.
3. Support conduit within 12 inches (300 mm) of enclosures to which attached.
4. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
5. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions. Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
6. Coat field-cut threads on PVC-coated raceways with a corrosion=preventing conductive compound prior to assembly.
7. Raceway Terminations at Locations Subject to Moisture or Vibration. Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
8. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch (35mm) trade size and insulated throat metal bushings on 1-1/2-inch (41-mm) trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
9. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

10. Do not rely on locknuts or penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
11. Cut conduit perpendicular to the length. For conduits 2-inch (53 mm) trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.
12. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.

C. Installation of raceways below ground
   1. General
      a. Arrange stub-ups so curved portions of bends are not visible above finished slab.
      b. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
      c. Couple steel conduits to raceways of different material using adapters listed for the application and encase coupling with 3 inches (75 mm) of concrete for a minimum of 12 inches (300 mm) on each side of the coupling.
      d. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
   2. Direct Buried
      a. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom with a minimum of 3" sand bed for raceways.
      b. Direct buried conduits, not installed in duct bank, shall be installed a minimum of 18 inches below finished grade. Comply with NEC unless noted otherwise on the Drawings.
         1) Provide PVC spacers at 5 feet on center to maintain 2" of separation between raceways in multiple raceway applications.
         2) Maintain 12 inches of earth or 2 inches of concrete separation between electrical conduits and other services or utilities below grade. Maintain 10 feet separation between parallel underground power and voice/data conduits. Where power and voice/data conduits cross below grade, crossing shall be at right (90 degree) angles with a minimum 2 feet vertical separation.
      c. Install breathers and drains unless the electrical equipment is installed indoors. Breathers and drains shall also be installed in enclosures to ensure draining of all liquids that condense or otherwise enter the enclosure. Conduit systems shall be installed in such a manner as to minimize the accumulation of moisture at low points and pockets. Where low points and pockets are unavoidable, a conduit fitting at the low point with a drain plug shall be installed. Vertical conduits located outdoors that enter equipment or device enclosures shall be low point drain fittings; conduit entry to enclosures shall be through the side or bottom. Conduit top entries shall be avoided and if required shall be reviewed and approved by Authority Having Jurisdiction. Conduits entering buildings shall have

low point drain fittings installed to prevent liquids that have collected in the conduits from entering the building conduit system.

d. After installing conduit, backfill and compact. Provide backfill material as follows:
   1) Provide 9" of sand backfill above raceways.
   2) Provide compacted select backfill above the sand.
      Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches (300 mm) of finished grade, make final conduit connection at end of run and complete backfilling with mechanical compaction to 90%, +/- 5%, in maximum 5" lifts.

e. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.

f. Warning Planks: Bury warning planks approximately 12 inches (300 mm) above direct-buried conduits but a minimum of 6 inches (150 mm) below grade. Align planks along centerline of conduit.]

g. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."]

3. Ductbanks
   a. Power duct banks shall be of individual conduits, encased in steel reinforced concrete. Conduit material shall be rigid PVC Schedule 40, except that rigid steel conduit or RTRC shall be used for the final 10 feet at the beginning and end of each duct bank and for all elbows and stub-ups. The reinforced concrete encasement surrounding the duct bank shall be rectangular in cross section, having a minimum concrete thickness of 3 inches. Conduits shall be separated by a minimum 2 inch concrete thickness, except that light and power conduit shall be separated from control and signal conduits by a minimum concrete thickness of 3 inches. Encasement concrete shall be red in color.
   b. Concrete may be omitted for any portion of the run that is directly below a building slab on grade.
   c. Changes in direction of duct bank runs exceeding a total of 10 degrees, either vertical or horizontal, shall be accomplished by long sweep bends having a minimum radius of curvature of 5 feet. All bends in a run shall be separated by a minimum of 10 feet of straight conduit, where possible.
   d. During construction, partially completed duct banks shall be protected from the entrance of debris such as mud, sand, and dirt by means of suitable conduit plugs. As each section of the duct bank is completed, a testing mandrel shall be drawn through each conduit. A brush with stiff bristles shall be drawn through until each conduit is clear of all particles of earth, sand, or gravel. Conduit plugs shall then be immediately installed and temporarily sealed.
   e. Ducts in concrete encased duct banks shall be independently supported by interlocking module spacers manufactured by Formex or approved substitution. Spacers shall provide separation between adjacent ducts as specified hereinabove. Spacers shall be installed at maximum 6 feet intervals.

4. Raceways in slab
    a. Run conduit larger than 1-inch (27-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot (3-m) intervals.
    b. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
    c. Arrange raceways to keep a minimum of 2 inches (50 mm) of concrete cover in all directions. Do not install conduits within concrete slabs less than 6 inches (150 mm) thick.
    d. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.

D. Installation of empty raceway systems:
1. Provide pull wires for empty raceway systems. The pull wire shall be No. 14 AWG zinc-coated steel, or plastic having not less than 200 pounds tensile strength. Not less than 12 inches of slack shall be left at each end of the pull wire.

E. Installation of wireways and cabinets
1. General: Install wireways and cabinets where shown and comply with specifications, in accordance with the manufacturer's written instructions, NEC, NECA's "Standard of Installation", and with recognized industry practices to ensure that the installation complies with the specified requirements and serve the intended purposes. Comply with requirements of NEMA and the NEC pertaining to installation of wireways.
2. Finishing: Remove burrs and sharp edges of wireways and cabinets to avoid damage to wiring insulation or jacket.
3. Grounding: Electrically ground wireways and cabinets to ensure continuous electrical conductivity. Refer to Section 26 0526 "Grounding and Bonding for Electrical Systems."
4. Cables:
    a. Complete wireway and cabinet installation before starting the installation of cables.
    b. Provide sufficient space to permit access for installing, splicing, and maintaining the cables.
    c. Provide slack cable, where noted on the Drawings, to provide flexibility for future taps and modifications.
    d. Provide retaining clips on minimum 5 feet on center where the raceway orientation will allow cables to shift or fall out when the cover is opened and removed.

F. Installation of Boxes
1. Provide junction and pull boxes for feeders and branch circuits where shown. Provide additional pull boxes where required by the NEC.
2. Install in compliance with NEC requirements, these specifications, or in accordance with the manufacturer's written instructions and with recognized industry practices to ensure that the boxes and fittings serve the intended purposes.
3. Where boxes are concealed in exterior walls, the continuity of the vapor barrier shall be maintained behind the box.
4. Use outlet and switch boxes for junctions on concealed conduit systems except in utility areas where exposed junction or pull boxes may be located.

5. Determine from the Drawings and by actual determination on the site, the exact location of each outlet. The outlet locations shall be modified from those shown to accommodate changes in door swings or to clear other interferences that may arise from job construction details, as well as modification to center them within room spaces. These modifications shall be made with no change in contract price and shall be a matter of job coordination. Check these conditions throughout the entire job and notify the Engineer of discrepancies, as they may occur, to verify the modifications, if any, before proceeding with the installation of the work. Set wall boxes in advance of wall construction, blocked in place and secured. Set all wall boxes flush with the finish and install extension rings as required to extend boxes to the finished surfaces of special furring or wall finishes.
6. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
7. On exposed conduit systems, provide pull boxes, junction boxes, wiring troughs, and cabinets wherever necessary for proper installation of various electrical systems.
8. Do not install pullboxes or wireways for the following purposes:
   a. to aggregate homeruns to panelboards
   b. to contain wiring from circuits originating in different panelboards.
   c. to contain wiring from systems with different voltages.
9. Provide weatherproof boxes for interior and exterior locations exposed to weather or moisture.
10. Provide knockout closures to cap unused knockout holes where blanks have been removed. Maintain 48 inches minimum clearance in front of branch box circuitry.
11. Locate boxes and conduit bodies to ensure accessibility of electrical wiring. Never set junction boxes above lights on lay-in ceilings.
12. Secure boxes rigidly to the substrate upon which they are being mounted, or solidly imbed boxes in concrete or masonry. Boxes shall not be permitted to move laterally. Boxes shall be secured between two studs. Two gang (single or double device) boxes may be connected to one stud using an approved bracket, except where specific dimensioned locations must be met. Box recessing depths shall comply with Article 314.24 of the National Electrical Code.
13. Boxes for any conduit system shall not be secured to the ceiling system, HVAC ductwork, or mechanical piping.
14. Coordinate locations of boxes in fire rated partitions and slabs so as to not affect the fire rating of the partition or slab. Notify the Engineer in writing where modifications or additional construction are required to maintain the partition or slab fire rating.
15. All junction boxes in accessible locations shall be marked with a permanent marker to identify the circuit(s) including voltage level within the box and on box cover.
16. Junction boxes utilized for emergency circuits shall be painted red in color.
17. Do not locate wall outlet boxes back-to-back in the same stud wall cavity. Ensure that communications and electrical outlet boxes are placed at least one stud or 16 inches apart when located on opposite sides of a partition wall.

18. The following requirements shall apply to exposed as well as concealed conduit systems when "gang" boxes shall be used. These "gang" boxes shall have dimensions which are not smaller than those shown in the following table:

NUMBER IN GANG	SIZE
3	4-1/2 inches by 8-5/8 inches
4	4-1/2 inches by 10-1/2 inches
5	4-1/2 inches by 10-1/2 inches
6	4-1/2 inches by 14 inches

19. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
20. Switch boxes shall not be used as junction boxes. They should only contain the wiring pertaining to the circuit.
21. Install boxes in walls without damaging wall insulation.
22. Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes.
23. In inaccessible ceiling areas, position outlets and junction boxes within 6 inches of recessed luminaire, to be accessible through luminaire ceiling opening.
24. Outlet boxes supporting fixtures shall be securely anchored in place in an approved manner. Support outlet boxes and fixtures in acoustic ceiling areas from building structures, not from acoustic ceilings. Light fixture outlets shall be coordinated with mechanical and architectural equipment and elements to eliminate conflicts and provide a workable neat installation. Also, stabilize box hanger with use of caddy T-bar.
25. Set floor boxes level and flush with floor. Install nonrated floor boxes as detailed on the Drawings.
26. Locate pull boxes and junction boxes in easily accessible area, above accessible ceilings or in unfinished areas.
27. Where outlet or switch boxes are not supported from studs or joists directly, they shall be supported by expandable clip type bar hangers, Appleton Catalog No. SX 18 or SX 26. In no case shall conduit be used to support switch or outlet boxes or caddy adjustable box bracket.
28. Outlet boxes in plaster partitions shall be "shallow-type" set flush in wall so there is at least 5/8 inch plaster covering back of box. Box size shall be 4 inches x 4 inches x 2 1/8 inches or 1 1/2 inches depending on application.
29. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
30. Horizontally separate boxes mounted on opposite sides of walls, so they are not in the same vertical channel.
31. Locate boxes so that cover or plate will not span different building finishes.
32. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
33. Set metal floor boxes level and flush with finished floor surface.
34. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

G. Installation of Handholes
   1. Install handholes in accordance with the details, where shown on the Contract Documents and manufacturer's written installation instructions. Handholes shall be rigidly supported and level with the top of manhole rings flush with finished paving or grade at the point of installation.

H. Surface Raceways:
   1. General: Install surface raceways where shown and comply with specifications, in accordance with the manufacturer's written instructions, NEC, NECA's "Standard of Installation", and with recognized industry practices to ensure that surface raceways comply with the specified requirements and serve the intended purposes.
   2. Mounting: Mount surface raceways in accordance with the manufacturer's listed installation instructions and the requirements of the local Electrical Inspection Department.
   3. Install surface raceway with a minimum 2-inch (50-mm) radius control at bend points.
   4. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches (1200 mm) and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.
   5. Protection of surface raceway receptacles
      a. General: Upon installation of multi-outlet surface raceways, advise Contractor regarding proper and cautious use of convenience outlets. At the time of Substantial Completion, replace those items which have been damaged, including those burned and scored by faulty plugs.
   6. Testing
      a. General: Prior to energization, check for continuity of circuits, for short circuits and check grounding connections. Verify that each individual raceway outlet is energized and that hot, neutral and ground conductors are properly connected.

I. Specialty Fittings:
   1. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.
   2. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
      a. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
      b. Where an underground service raceway enters a building or structure.
      c. Where otherwise required by NFPA 70.
   3. Cable Support Fittings: Install in long vertical raceways according to spacing requirements in NEC Table 300.19(A) "Spacings for Conductor Supports". Locate fittings in an accessible location and provide access doors where raceway is concealed behind wall or ceiling finishes.

J. Expansion-Joint Fittings:
   1. Locations Required:

a. Install in vertical section of conduit stub-ups routed through underfloor spaces, below the sleeved floor opening.
b. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F (17 deg C) and that has straight-run length that exceeds 25 feet (7.6 m).
c. Install in each run of aboveground RMC conduit that is located where environmental temperature change may exceed 100 deg F (55 deg C) and that has straight-run length that exceeds 100 feet (30 m).

2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F (70 deg C) temperature change.
b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F (86 deg C) temperature change.
c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F (70 deg C) temperature change.
d. Attics: 135 deg F (75 deg C) temperature change.
3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C) of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F (0.0115 mm per meter of length of straight run per deg C) of temperature change for steel conduits.
4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

K. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches (1830 mm) of flexible conduit for recessed and semi-recessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
1. Use LFMC in damp or wet locations subject to severe physical damage.
2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

3.4 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.5 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.6 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by image to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 260533

SECTION 260544 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DESCRIPTION OF WORK

A. Section Includes:
   1. Sleeves for raceway and cable penetration of non fire-rated construction walls and floors.
   2. Sleeve-seal systems.
   3. Sleeve-seal fittings.
   4. Grout.
   5. Silicone sealants.

1.3 SUBMITTALS

A. Shop Drawing submittals shall include, but not be limited to, the following:
   1. The Contractor shall submit to the Engineer for review cutsheets of proposed products.

B. Closeout Submittal
   1. Include final version of approved shop drawing submittals within the Operation and Maintenance manual.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Wall Sleeves:
   1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
   2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

C. Sleeves for Rectangular Openings:
   1. Material: Galvanized sheet steel.
   2. Minimum Metal Thickness:

a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and with no side larger than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
b. For sleeve cross-section rectangle perimeter 50 inches (1270 mm) or more and one or more sides larger than 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.2 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
1. Manufacturers: Subject to compliance with requirements, Subject to compliance with requirements, provide products by the following:
a. Advance Products & Systems, Inc.
b. CALPICO, Inc.
c. Metraflex Company (The).
d. Pipeline Seal and Insulator, Inc.
e. Proco Products, Inc.
f. Eaton – Crouse Hinds
g. GPT Industries
2. Sealing Elements: EPDM or Nitrile (Buna N) rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Plastic or Stainless steel.
4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.
1. Manufacturers: Subject to compliance with requirements, Subject to compliance with requirements, provide products by the following:
a. Presealed Systems.

2.4 GROUT

A. Description: Non-shrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.

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

C. Design Mix: 5,000-psi (34.5-MPa), 28-day compressive strength.

D. Packaging: Pre-mixed and factory packaged.

2.5 SILICONE SEALANTS

A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
   1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

B. Silicone Foams: Multi-component, silicone-based, liquid elastomers that, when mixed, expand and cure in place to produce a flexible, non-shrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

B. Comply with NEMA VE 2 for cable tray and cable penetrations.

C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
   1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
      a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
      b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
   2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
   3. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.
   4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
   5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches (50 mm) finished floor level. Install sleeves during erection of floors.

D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
   1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
   2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

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

B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

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

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

C. Secure nailing flanges to concrete forms.

D. Seal the space around the outside of sleeve-seal fittings with grout.

END OF SECTION 260544

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DESCRIPTION OF WORK

A. Work Included: Provide identification for electrical systems as shown, scheduled, indicated, and specified.

B. Types: The types of identification for electrical systems required for the Project include, but are not limited to:
   1. Electrical system identification.
   2. Warning signs and operational tags.
   3. Cleaning and painting of electrical work.

1.3 QUALITY ASSURANCE

A. Comply with ANSI A13.1 and IEEE C2.

B. Comply with NFPA 70 and 70E.

C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

D. Comply with ANSI Z535.4 for safety signs and labels.

E. Comply with NFPA 70 and NFPA 70E requirements for ARC-flash warning labels

1.4 SUBMITTALS

A. Shop Drawing submittals shall include, but not be limited to, the following:
   1. Cut sheets and samples of Electrical System Identification products.
   2. Additional information as required in the Contract Documents.

1.5 QUALITY ASSURANCE

A. Comply with ANSI A13.1.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

D. Comply with ANSI Z535.4 for safety signs and labels.

E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.6 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

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

C. Coordinate installation of identifying devices with location of access panels and doors.

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

PART 2 - PRODUCTS

2.1 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Write-On Tags: Polyester tag, 0.010 inch (0.25 mm) thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

C. Snap-Around Labels: Slit, pre-tensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

2.2 CONDUCTOR IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.

2.3 FLOOR MARKING TAPE

A. 2-inch- (50-mm-) wide, 5-mil (0.125-mm) pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

2.4 DETECTABLE UNDERGROUND-LINE WARNING TAPE

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
   1. Manufacturers: Subject to compliance with requirements, provide products by the following:
      a. Brady
      b. Scotch
      c. Presco
      d. Trumbull MFG.

B. Tape:
   1. Minimum 5.0 mil overall thickness with .35 mil, solid aluminum foil core.
   2. Printing on tape shall be permanent and shall not be damaged by burial operations.
   3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

C. Color and Printing:
   1. Comply with ANSI Z535.1 through ANSI Z535.5.
   2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE, .
   3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.

D. Tape Width:
   1. Minimum tape width shall correspond to burial depth below final, finished grade as follows:
      a. 2" wide for 6"-12" installed depth, below finished grade.
      b. 3" wide for 12"-24" installed depth, below finished grade.
      c. 6" wide for 22"-30" installed depth, below finished grade.

2.5 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.

C. Warning label and sign shall include, but are not limited to, the following legends:
   1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
   2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 MM)."
   3. ARC FLASH

2.6 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. inches (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes.

1. Engraved legend with black letters on white face.
2. Punched or drilled for mechanical fasteners.
3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.7 EQUIPMENT IDENTIFICATION LABELS

A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch (10 mm).

B. Stenciled Legend: In non-fading, waterproof, black ink or paint. Minimum letter height shall be 1 inch (25 mm).

2.8 CABLE TIES

A. General-Purpose Cable Ties: Fungus inert, self extinguishing, one piece, self locking, Type 6/6 nylon.
1. Minimum Width: 3/16 inch (5 mm).
2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 12,000 psi (82.7 MPa).
3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
4. Color: Black except where used for color-coding.

B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self extinguishing, one piece, self locking, Type 6/6 nylon.
1. Minimum Width: 3/16 inch (5 mm).
2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 12,000 psi (82.7 MPa).
3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
4. Color: Black.

C. Plenum-Rated Cable Ties: Self extinguishing, UV stabilized, one piece, self locking.
1. Minimum Width: 3/16 inch (5 mm).
2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 7000 psi (48.2 MPa).
3. UL 94 Flame Rating: 94V-0.
4. Temperature Range: Minus 50 to plus 284 deg F (Minus 46 to plus 140 deg C).
5. Color: Black.

2.9 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Verify the identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

F. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.

G. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.

H. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:
   1. Outdoors: UV-stabilized nylon.
   2. In Spaces Handling Environmental Air: Plenum rated.

I. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line. Depth below final finished grade shall not exceed amount indicated per these specifications or as published in the tape manufacturer's installation instructions. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches (400 mm) overall.

3.2 IDENTIFICATION SCHEDULE

A. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. Provide identification products after completion of all finished painting. System legends shall be as follows:
   1. Emergency Power.
   2. Power.
   3. UPS.

B. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.

1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder, and branch-circuit conductors.
   a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities have jurisdiction permit.
   b. Colors for 208/120-V Circuits:
      1) Phase A: Black.
      2) Phase B: Red.
      3) Phase C: Blue.
   c. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

C. Power-Circuit Conductor Identification, more than 600 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use write-on tags and a separate tag with the circuit designation].

D. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.

E. Conductors to be extended in the future: Attach write-on tags to conductors and list source.

F. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
   1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
   2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
   3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.

G. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
   1. Install underground-line detectable warning tape for both direct-buried cables and cables in raceway.

H. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install flush-mounted panelboards and similar equipment in finished spaces.

I. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.
   1. Comply with 29 CFR 1910.145.
   2. Identify system voltage with black letters on an orange background.
   3. Apply to exterior of door, cover, or other access.
   4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:
      a. Power transfer switches.
      b. Controls with external control power connections.

J. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

K. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch- (10-mm-) high letters for emergency instructions at equipment used for power transfer or load shedding.

L. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
   1. Labeling Instructions:
      a. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high label; where two lines of text are required, use labels 2 inches (50 mm) high.
      b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
      c. Elevated Components: Increase the sizes of labels and letters to those appropriate for viewing from the floor.
      d. Fasten labels with appropriate stainless steel mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.
   2. Equipment to be Labeled:
      a. Panelboard identification shall be engraved, laminated acrylic or melamine label.
      b. Enclosures and electrical cabinets.
      c. Access doors and panels for concealed electrical items.
      d. Emergency system boxes and enclosures.
      e. Enclosed switches.
      f. Enclosed circuit breakers.
      g. Enclosed controllers.
      h. Variable-speed controllers.
      i. Push-button stations.
      j. Power transfer equipment.
      k. Contactors.
      l. Remote-controlled switches, dimmer modules, and control devices.
      m. Battery-inverter units.
      n. Power-generating units.
      o. Monitoring and control equipment.
      p. UPS equipment.
   3. Equipment Requiring Directory and/or branch device labels:
      a. Panelboards: Typewritten directory of circuits corresponding to "as-installed" device and load locations.
      b. Lighting Control panels
      c. Dimmer circuits.
      d. Monitoring and control equipment.

END OF SECTION 260553

SECTION 260573 - POWER SYSTEMS STUDIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DESCRIPTION OF WORK

A. General
1. Scope - The contractor shall provide an engineering analysis and power system studies for the entire electrical system as required hereinbelow.
2. The Short Circuit Analysis, Protective Device Coordination Study, and Arc Flash and Electrical Hazard Studies specified in this section shall be completed and submitted prior to submitting submittals for panelboards, enclosed circuit breakers and other electrical gear with short circuit or interrupting ratings.
3. The power system studies shall be performed in SKM with the final native files provided to the Owner. The contractor shall perform a Power System Short Circuit Analysis, Protective Device Coordination Study, and Arc Flash and Electrical Hazard Study. These analyses and studies shall include all power distribution systems, beginning at the electric service point from the Electric Utility Company or campus utility power source [and emergency power source(s)] to the secondary buses of each panelboard as described hereafter. In addition, include harmonic systems and ground grid studies.
4. The electrical studies shall be prepared by and certified with a registration seal and signature of a Registered Professional Engineer. The Engineer shall be qualified by experience in preparation of studies having similar requirements and of similar magnitude to that specified in this section of the Specifications.
5. The Load Flow Analysis shall start at the electrical power source and terminate at each branch bus at the lowest utilization voltage. The load flow analysis shall also include a voltage drop study beginning at the electrical power source and terminate at each branch bus at the lowest utilization voltage.]
6. The Short Circuit Analysis shall terminate at each branch bus at the lowest utilization voltage secondary bus where the symmetrical short circuit RMS amperes, total source plus all motor contribution, is less than 10,000 amperes for 208V. The short circuit analysis shall compare interrupting rating of all installed electrical protective devices connected to each bus included in the study with that of the available fault current at the load terminals of each protective device. Appropriate recommendations shall be made for corrective action in the conclusions of the report where the interrupting rating of electrical equipment is exceeded by the available fault current.
7. The Protective Device Coordination Study shall start at the electric service and include all electrical distribution equipment protective devices with adjustable trip units, relay settings or options for fuse types. The curves and settings for the Power Company protective devices shall be included in the scope of this study. The coordination plots shall terminate with the first non-adjustable overcurrent device or devices downstream of all protective devices with an adjustable trip unit, relay settings or options for fuse types. The protective device study shall include a separate analysis for phase and ground protection.

8. The Arc Flash and Electrical Hazard Study comply with applicable NEC and OSHA requirements and shall include calculating the Arc Flash and establishing the Electrical Hazard rating for each electrical equipment such as, but not limited to, switchgear, switchboard, distribution panel, panelboard, automatic transfer switch, enclosed circuit breaker and disconnect switch to be installed on the project. If the Arc flash energy exceeds 40 cal/cm^2, an Arc flash energy reduction option shall be reviewed and provided by the Engineer to the Owner for review and approval. The intention is to lower the energy to the extent possible, preferably less than 10 cal/cm^2.
9. The Contractor shall obtain all lengths of cable from the electrical drawings and, where not shown the entire length of the run, from Contractor estimated lengths to longest possible lengths. All other equipment ratings shall be obtained by the Contractor from the equipment manufacturers and/or suppliers.

B. Short Circuit Analysis: The Analysis shall include the following:
1. A schematic one-line drawing of the entire electrical system included in the study, from the power company system including the point of delivery, to each primary transformer, and including all main secondary buses of each transformer included in the study. Secondary buses shall include multiple secondary transformations within the scope of the study. Each device shall be identified using project assigned identification labels. Each motor 10 hp and larger shall be shown and identified. Each bus shall be assigned an identification number.
2. Source voltage and impedance data shall be given in the analysis, including reactance and resistance in OHMS to the source, and available symmetrical and asymmetrical short circuit amperes at the point of delivery of electrical power. Short circuit amperes shall be based on an assumed bolted 3 phase short circuit and phase to ground short circuit.
3. At each bus, including buses of all primary protective and switching devices, primary and secondary of all transformers, all secondary main and feeder breakers, and all secondary devices and panelboards within the scope of the study, the following shall be calculated for assumed bolted 3 phase short circuits.
    a. Symmetrical RMS short circuit amperes calculated using total source and motor contribution reactance and resistance values.
    b. Asymmetrical average 3 phase RMS amperes at 1/2 cycle, calculated using actual total source and motor contribution X/R ratio.
    c. Reactance ("X") and Resistance ("R") in OHMS at the voltage of the device being examined, including both The Power Company source and all motor contributions.
4. Calculation sheets for cable sections shall indicate voltage, wire size, cable length, reactance and resistance of the section in OHMS and total "X" and "R" to the source.
5. Calculation sheets for transformer sections shall indicate transformer kVA, secondary voltage, percent impedance, percent reactance, percent resistance, and total "X" and "R" value in OHMS at the secondary voltage to source, including The Power Company source impedance plus any primary motor contribution.
6. Calculation sheets for busway and miscellaneous devices shall provide all pertinent parameters including operating voltage, section "X" and "R" values in OHMS, and total "X" and "R" values in OHMS to the source, based on source impedance plus any motor contribution.
7. Bus summary sheets shall be provided giving consecutive bus numbers, description, voltage, "X" and "R" values in OHMS including The Power Company

plus all motor contributions, symmetrical and asymmetrical short circuit amperes, X/R ration, and asymmetrical factor.

8. Motor summary sheets shall provide motor description and all pertinent motor data including subtransient reactance for each motor 10 hp and larger. Symmetrical short circuit amperes shall be given for each motor at the motor terminals.
9. An evaluation of the adequacy of the short-circuit ratings of the electrical equipment supplied by that manufacturer. For this evaluation, circuit breakers shall all be fully rated.
10. All information shall be presented in a report form, signed and sealed by the engineer providing the analysis.

C. Protective Device Coordination Study: The Study shall include the following:

1. Time-current coordination plots shall be made on log-log sheets or equivalent software generated plots and shall graphically indicate the coordination proposed for all of the key systems. The plots shall include complete titles, one-line diagram and legend.
2. The Power Company's relay, fuse, or protective device shall be plotted with all load protective devices at the same voltage.
3. Transformer primary protective device, transformer magnetic inrush, transformer ANSI withstand points, secondary voltage fuse or circuit breaker and largest feeder fuse or circuit breaker shall be plotted at the secondary voltage. Circuit breaker curves shall include complete operating bands, terminating with the appropriate available short circuit current. Fuse curves shall be identified as either total clearing time or damage time as applicable.
4. Low voltage circuit breakers shall have instantaneous, short delay, long-time pick-up and ground fault trip settings and ground fault ampere and time delay settings identified as plotted. Sensor or monitor rating shall be stated for each circuit breaker. All regions of the circuit breaker curve shall be identified.
5. The coordination plots shall include motors greater than 50 HP that are starting on line (DOL), starting characteristics and protective devices.
6. Feeder circuit breakers shall have the time-damage curve of the feeder conductors plotted to indicate protection of the conductor insulation at the total clearing time of the circuit breaker or fuse. This time-damage point shall be calculated for the specific parameters of conductor insulation used, with average 3 phase RMS asymmetrical amperes as 1/2 cycle calculated using actual resistance and reactance values of the source plus all motor contributions which exist at the load end of the feeder conductors. Conductor initial temperature and conductor maximum transient temperature for short circuits as recommended by ICEA shall be indicated.
7. High voltage relays shall have coil taps, time-dial settings and pick-up settings identified as plotted. Current transformer ratios shall be stated. Relays shall be separated by a 0.45 second and 0.3 for electronic relays, time margin to assure proper selectivity where feasible. The relay operating curves shall be suitably terminated to reflect the actual maximum fault current sensed by the device.
8. A determination of settings or ratings for the overcurrent and ground fault protective devices supplied. Where necessary, an appropriate compromise shall be made between system protection and service continuity, with [service continuity] [system protection] considered more important than [system protection/service continuity.] The time-current coordination analysis shall be performed with the aid of appropriate software. In addition, Arc flash energy reduction consideration shall be included.

9. A summary tabulation shall be provided listing manufacturer and type for all overcurrent protective devices and all recommended settings of each adjustable band included in each device.
10. An evaluation of the degree of system protection and service continuity possible with the overcurrent devices supplied.
11. When main breaker is provided with setback to reduce the arc fault level both settings shall be included in the study.
12. All information shall be presented in a report form, signed and sealed by the Engineer providing the analysis.

D. Emergency Power System Selective Coordination Study: The Study shall include the following:
1. Confirmation of selective coordination of all overcurrent devices associated with supplying utility and generator/UPS to emergency loads in accordance with all applicable requirements of NEC Article 100 and Paragraphs 700.27 and 701.18. Study shall be based on coordination to [0.1] [0.01] seconds. Study shall be based on the actual electrical equipment and overcurrent protective devices being submitted for the project.
2. Time-current coordination plots shall be made on log-log sheets or equivalent software generated plots and shall graphically indicate the coordination proposed for all of the key systems. The plots shall include complete titles, one-line diagram and legend.
3. Circuit breakers shall indicate manufacturer and type and have instantaneous, short delay, long-time pick-up and ground fault trip settings and ground fault ampere and time delay settings identified as plotted. Sensor or monitor rating shall be stated for each circuit breaker. All regions of the circuit breaker curve shall be identified. Circuit breaker curves shall include complete operating bands, terminating with the appropriate available short circuit current.
4. Fuses shall have fuse manufacturer and type indicated. Fuse curves shall be identified as either total clearing time or damage time as applicable.
5. Microprocessor relays shall indicate manufacturer and type and have coil taps, time-dial settings and pick-up settings identified as plotted. Current transformer ratios shall be stated. Relays shall be separated by a 0.30 second time margin to assure proper selectivity where feasible. The relay operating curves shall be suitably terminated to reflect the actual maximum fault current sensed by the device.
6. A summary tabulation shall be provided listing manufacturer and type for all overcurrent protective devices and all recommended settings of each adjustable band included in each device.
7. Confirmation that the proposed overcurrent protection devices, set or selected as recommended, will provide the specified selective coordination. Should the overcurrent devices proposed for the project not be capable of providing the specified selective coordination, the report shall include recommendations for overcurrent protective device changes required to provide the specified coordination and calculations, plots, recommended settings as specified herein for the recommended overcurrent device changes to provide the specified selective coordination.
8. All information shall be presented in a report form, signed and sealed by the Engineer providing the analysis.

E. Arc Flash & Electrical Hazard Analysis: The Analysis shall include the following:

1. The Arc-Flash & Electrical Hazard Analysis (AFEHA) shall be performed in accordance with the requirements of NFPA 70 Section 110.16, NFPA 70E, NESC ANSI C2-2007 Section 410.A.3, IEEE Std. 1584 and OSHA 29 CFR 1910.132(d) and 1910.335.
2. The AFEHA shall:
   a. Calculate incident energy levels and flash protection boundaries at all relevant equipment busses based on available short-circuit current, protective device clearing time and other applicable one-line diagram information. Incident energy calculations shall be provided at line and load side. Including all DC systems.
   b. Calculate the, Arc Flash Boundary and incident energy for each switchboard, distribution panel, panelboard, automatic transfer switch, enclosed circuit breaker and disconnect switch to be installed on the project.
   c. Establish the Arc Flash Protection Boundary (Shock Protection Boundaries: Limited and restricted approach boundary) as required by NFPA 70E for each piece of electrical equipment such as, but not limited to, switchboard, distribution panel, panelboard, automatic transfer switch, enclosed circuit breaker and disconnect switch to be installed on the project.
   d. Provide equipment specific Arc-flash hazard warning label requirements per NEC Section 110.16 for each switchboard, distribution panel, panelboard, automatic transfer switch, enclosed circuit breaker, disconnect switch and all DC systems to be installed on the project, including all information specified to be provided on individual equipment warning labels. Arc Flash Labels shall meet all of the following requirements per NFPA 70 and 70E. Per NFPA 70E, equipment labeling, shall contain available incident energy and the corresponding working distance only. Arc Flash Energy greater than 40 cal/cm^2 shall be color coded red with additional notes that equipment shall not be operated. Arc Flash Labels shall be submitted to the Owner for review and approval of information to be included on labels.
   e. Provide recommendations and methods to mitigate the hazard risk, where applicable, in order to reduce PPE requirements. If the Arc flash energy exceeds 40 cal/cm^2, an Arc flash energy reduction option shall be provided to the Owner for review and approval. The intention is to lower the arc flash energy, if possible, to less than 10 cal/Cm^2.

1.3 STUDY AND ANALYSIS SEQUENCE

A. All studies and analysis specified herein shall be completed and submitted with electrical distribution equipment submittals to allow the Engineer to review submitted electrical distribution equipment for interrupting rating, coordination and arc flash related coordination.

1.4 QUALITY ASSURANCE

A. All electrical studies shall be performed by the Engineering Department of the electrical equipment supplier for the project or by a qualified engineering consultant.

1.5 SUBMITTALS

A. Shop drawing submittals shall include, but not be limited to, the following:
   1. Four copies of the Load Flow analysis including but not limited to:
      a. A printout of input data, calculated results and an explanation of how to interpret the data.
      b. A one-line diagram identifying all bus locations and the maximum available short-circuit current at each bus.
      c. A listing of the equipment regarding the normal current carrying capacity and normal current load. In addition, the voltage drop results shall be provided for every cable.]
   2. Four copies of the Short-Circuit Analysis including, but not limited to:
      a. A printout of input data, calculated results and an explanation of how to interpret the data.
      b. A one-line diagram identifying all bus locations and the maximum available short-circuit current at each bus.
      c. A bus-to-bus listing of the maximum available short-circuit current expressed in RMS symmetrical amperes and the X over R ratio of that fault current.
      d. A table of specified equipment short-circuit ratings versus calculated short-circuit current values with notations of locations where are specified equipment short-circuit ratings are less or greater than required at the point of application.
      e. An analysis of the results in which any overrating or inadequacies shall be called to the attention of the Engineer and recommendations made for improvements.
   3. Four copies of the Protective Device Coordination Study including, but not limited to:
      a. Time-current characteristic curve drawings on log-log printouts which illustrate:
         1) The recommended settings for all adjustable relays, overcurrent protective devices and ground fault protective devices provided for the project.
         2) The key or limiting overcurrent device characteristics, load characteristics, and protection requirements affecting the settings or ratings of the overcurrent protective devices supplied.
         3) The degree of service continuity and system protection achieved with the overcurrent protective devices supplied.
      b. A tabulation of the recommended settings for all adjustable relays, overcurrent protective devices and ground fault protective devices and type selections for fuse protective devices supplied.
      c. An analysis of the results in which any inadequacies related to selective coordination shall be called to the attention of the Engineer with recommendations for improved coordination.
   4. Four copies of the Emergency Power System Selective Coordination Study including, but not limited to:
      a. Time-current characteristic curve drawings on log-log printouts which illustrate:
         1) Compliance of the provided overcurrent protective devices with the specified selective coordination requirements.

2) The recommended settings for all adjustable relays, overcurrent protective devices and ground fault protective devices provided for the project.

b. A tabulation of the recommended settings for all adjustable relays, overcurrent protective devices and ground fault protective devices and type selections for fuse protective devices supplied.

c. An analysis of the results in which any inadequacies related to the specified selective coordination shall be called to the attention of the Engineer with recommendations for improved coordination.]

5. Four copies of all the electrical powers studies including, but not limited to:
   a. Minimum Arc Fault Current, Shock and Arc Flash Boundary and Arc Fault Rating (cal/cm^2) for each switchboard, distribution panel, panelboard, automatic transfer switch, enclosed circuit breaker and disconnect switch to be installed on the project.
   b. Arc Flash Hazard Category and risk of personnel injury as a result of exposure to incident energy released during an arc flash event for each switchboard, distribution panel, panelboard, automatic transfer switch, enclosed circuit breaker and disconnect switch to be installed on the project.
   c. Current appropriate ratings of personal protective equipment (PPE) for each switchboard, distribution panel, panelboard, automatic transfer switch, enclosed circuit breaker and disconnect switch to be installed on the project.
   d. The Arc Flash Protection Boundary (approach limit distance) as required by NFPA 70 and NFPA 70E for each switchboard, distribution panel, panelboard, automatic transfer switch, enclosed circuit breaker and disconnect switch to be installed on the project.
   e. Equipment specific environment and chemical arc-flash hazard warning label requirements per NEC Section 110.16 and NFPA 70E for each switchboard, distribution panel, panelboard, automatic transfer switch, enclosed circuit breaker and disconnect switch to be installed on the project, including all information specified to be provided on individual equipment warning labels.
   f. Recommendations and methods to mitigate the hazard risk, where applicable, in order to reduce PPE requirements.
6. Cut sheets and submittal information on the Arc Flash warning labels being provided.
7. Additional information as required in Section 26 0001 "Basic Requirements for Electrical".
8. Contractor to provide all electronic data files (SKM, ETAP, etc.) to Owner at the conclusion of the project as part of close out documentation.

PART 2 - PRODUCTS

2.1 ARC FLASH WARNING LABELS

A. Labels: Seton Write-On Arc Flash Warning Labels or an approved equal labels with NEC and OSHA required warning information. If the Arc flash energy exceeds 40 cal/cm^2, an Arc flash energy reduction option shall be provided to the Owner for review and approval. The intention is to lower the energy, if possible, to less than 10 cal/cm^2.

PART 3 - EXECUTION

3.1 PROTECTIVE DEVICE SELECTION AND SETTING

A. Settings and Selection: Prior to project Substantial Completion, the Contractor shall set all relays, overcurrent devices and ground fault protection devices and confirm selection of fuse overcurrent devices as follows:
   1. Relays: Reset all adjustable relay settings from the factory default settings to the settings recommended in the studies specified in this section.
   2. Circuit Breakers: Reset all adjustable trip settings from the factory default settings to the settings recommended in the studies specified in this section.
   3. Ground Fault Protection Devices: Reset all adjustable device settings from the factory default settings to the settings recommended in the studies specified in this section.
   4. Fuses: Confirm that fuse types installed on the project are as recommended in the studies specified in this section.

B. Certification: Prior to project Substantial Completion, the Contractor shall submit 4 signed copies of a document certifying that the Contractor has completed the settings and selection scope specified in Paragraph 3.1 A. to the Engineer.

3.2 ARC FLASH WARNING LABELS

A. Installation: Arc Flash warning labels shall be securely affixed to each of electrical equipment such as, but not limited to, distribution panel, panelboard, automatic transfer switch, enclosed circuit breaker, disconnect switch and all DC battery systems in a readily visible location in accordance with NEC and OSHA requirements.

END OF SECTION 260573

SECTION 260923 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Time switches.
2. Photoelectric switches.
3. Standalone daylight-harvesting switching controls.
4. Indoor occupancy sensors.
5. Outdoor motion sensors.
6. Lighting contactors.
7. Emergency shunt relays.

B. Related Requirements:
1. Section 262726 "Wiring Devices" for wall-box dimmers, wall-switch occupancy sensors, and manual light switches.

1.3 DEFINITIONS

A. LED: Light-emitting diode

B. PIR: Passive infrared

1.4 SUBMITTALS

A. Shop Drawing submittals shall include, but not be limited to, the following:
1. Product Data: For each type of lighting control device proposed for use on the project.
2. Shop Drawings: Showing installation details for occupancy and light-level sensors. Provide interconnection diagrams showing field installed wiring. Include diagrams for power, signal, and control wiring.

B. Closeout Submittal
1. Include final version of approved shop drawing submittals within the Operation and Maintenance manual.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.6 COORDINATION

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 TIME SWITCHES

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
1. NSi Industries LLC; TORK Products.
2. Cooper Industries, Inc.
3. Intermatic, Inc.
4. Lutron Electronics Co., Inc
5. Square D; Schneider Electric.
6. Leviton Mfg. Company Inc.
7. Watt Stopper (The).
8. Tyco Electronics; ALR Brand.
9. Lithonia Lighting; Acuity Lighting Group, Inc.

B. Electronic Time Switches: Solid state, programmable, with alphanumeric display; complying with UL 917.
1. Contact Configuration: As indicated on the drawings
2. Contact Rating: 30-A inductive or resistive, 240-V ac.
3. Programs: Eight on-off set points on a 24-hour schedule
4. Programs: Two on-off set points on a 24-hour schedule, allowing different set points for each day of the week.
5. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program.
6. Astronomic Time: All channels.
7. Automatic daylight savings time changeover.
8. Battery Backup: Not less than seven days reserve, to maintain schedules and time clock.

C. Electromechanical-Dial Time Switches: Comply with UL 917.
1. Contact Configuration: As indicated on the drawings
2. Contact Rating: 30-A inductive or resistive, 240-V ac.
3. Circuitry: Allows connection of a photoelectric relay as a substitute for the on-off function of a program.
4. Astronomic time dial.
5. Eight-Day Program: Uniquely programmable for each weekday and holidays.
6. Skip-a-day mode.

7. Wound-spring reserve carryover mechanism to keep time during power failures, minimum of 16 hours.

2.2 OUTDOOR PHOTOELECTRIC SWITCHES

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   1. Cooper Industries, Inc.
   2. Intermatic, Inc.
   3. NSi Industries LLC; TORK Products.
   4. Watt Stopper (The).

B. Description: Solid state, with DPST dry contacts rated for 1800-VA tungsten or 1000-VA inductive, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.
   1. Light-Level Monitoring Range: 1.5 to 10 fc (16.14 to 108 lux), with an adjustment for turn-on and turn-off levels within that range, and a directional lens in front of the photocell to prevent fixed light sources from causing turn-off.
   2. Time Delay: Fifteen second minimum, to prevent false operation.
   3. Surge Protection: Metal-oxide varistor, complying with IEEE C62.41.1, IEEE C62.41.2, and IEEE 62.45 for Category A1 locations.
   4. Mounting: Twist lock complies with NEMA C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.

2.3 DAYLIGHT-HARVESTING SWITCHING CONTROLS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   1. Cooper Industries, Inc.
   2. Eaton Corporation.
   3. Hubbell Building Automation, Inc.
   4. Leviton Mfg. Company Inc.
   5. Lithonia Lighting; Acuity Lighting Group, Inc.
   6. NSi Industries LLC; TORK Products.
   7. Sensor Switch, Inc.
   8. nLight Controls.
   9. Watt Stopper.
   10. Lutron Electronics Co., Inc

B. Ceiling-Mounted Switching Controls: Solid-state, light-level sensor unit, with separate power pack/relay, to detect changes in indoor lighting levels that are perceived by the eye.

C. Electrical Components, Devices, and Accessories:
   1. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F (0 to 49 deg C).
   2. Sensor Output: Contacts rated to operate the associated power pack, complying with UL 773A. Sensor is powered by the power pack.

3. Power Pack: Dry contacts rated for 20A ballast load at 120- and 277-V ac, for 13A tungsten at 120-V ac, and for 1hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
4. General Space Sensors Light-Level Monitoring Range: 10 to 200 fc (108 to 2152 lux), with an adjustment for turn-on and turn-off levels within that range.
5. Atrium Space Sensors Light-Level Monitoring Range: 100 to 1000 fc (1080 to 10 800 lux), with an adjustment for turn-on and turn-off levels within that range.
6. Skylight Sensors Light-Level Monitoring Range: 1000 to 10,000 fc (10 800 to 108 000 lux), with an adjustment for turn-on and turn-off levels within that range.
7. Time Delay: Adjustable from 5 to 300 seconds to prevent cycling.
8. Set-Point Adjustment: Equip with deadband adjustment of 25, 50, and 75 percent above the "on" set point, or provide with separate adjustable "on" and "off" set points.
9. Test Mode: User selectable, overriding programmed time delay to allow settings check.
10. Control Load Status: User selectable to confirm that load wiring is correct.
11. Indicator: Two digital displays to indicate the beginning of on-off cycles.

2.4 DAYLIGHT-HARVESTING DIMMING CONTROLS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
1. Cooper Industries, Inc.
2. Hubbell Building Automation, Inc.
3. Leviton Mfg. Company Inc.
4. Lithonia Lighting; Acuity Lighting Group, Inc.
5. Watt Stopper.
6. Lutron Electronics Co., Inc
7. nLight Controls

B. System Description: Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, the lights are dimmed.
1. Lighting control set point is based on two lighting conditions:
   a. When no daylight is present (target level).
   b. When significant daylight is present.
2. System programming is done with two hand-held, remote-control tools.
   a. Initial setup tool.
   b. Tool for occupants to adjust the target levels by increasing the set point up to 25 percent, or by minimizing the electric lighting level.

C. Ceiling-Mounted Dimming Controls: Solid-state, light-level sensor unit, with separate controller unit, to detect changes in lighting levels that are perceived by the eye.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Sensor Output: 0- to 10-V dc to operate electronic dimming ballasts. Sensor is powered by controller unit.
3. Power Pack: Sensor has 24-V dc, Class 2 power source, as defined by NFPA 70.
4. Light-Level Sensor Set-Point Adjustment Range: 20 to 60 fc (120 to 640 lux).

2.5 INDOOR OCCUPANCY SENSORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
1. Hubbell Building Automation, Inc.
2. Leviton Mfg. Company Inc.
3. Lithonia Lighting; Acuity Lighting Group, Inc.
4. Lutron Electronics Co., Inc.
5. NSi Industries LLC; TORK Products.
6. Sensor Switch, Inc.
7. Square D; a brand of Schneider Electric.
8. Watt Stopper.

B. General Requirements for Sensors: Wall- or ceiling-mounted, solid-state indoor occupancy sensors with a separate power pack.
1. Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor is powered from the power pack.
3. Power Pack: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
4. Mounting:
   a. Sensor: Suitable for mounting in any position on a standard outlet box.
   b. Relay: Externally mounted through a 1/2-inch (13-mm) knockout in a standard electrical enclosure.
   c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
5. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
6. Bypass Switch: Override the "on" function in case of sensor failure.
7. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (21.5 to 2152 lux); turn lights off when selected lighting level is present.

C. PIR Type: Ceiling mounted; detect occupants in coverage area by their heat and movement.
1. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm).
2. Detection Coverage (Room): Detect occupancy anywhere in a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
3. Detection Coverage (Corridor): Detect occupancy within 90 feet (27.4 m) when mounted on a 10-foot- (3-m-) high ceiling.

D. Ultrasonic Type: Ceiling mounted; detect occupants in coverage area through pattern changes of reflected ultrasonic energy .
1. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).

2. Detection Coverage (Small Room): Detect occupancy anywhere within a circular area of 600 sq. ft. (56 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
4. Detection Coverage (Large Room): Detect occupancy anywhere within a circular area of 2000 sq. ft. (186 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
5. Detection Coverage (Corridor): Detect occupancy anywhere within 90 feet (27.4 m) when mounted on a 10-foot- (3-m-) high ceiling in a corridor not wider than 14 feet (4.3 m).

E. Dual-Technology Type: Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.
1. Sensitivity Adjustment: Separate for each sensing technology.
2. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm) and detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.

2.6 HIGH-BAY OCCUPANCY SENSORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
1. Hubbell Building Automation, Inc.
2. Leviton Mfg. Company Inc.
3. Lithonia Lighting; Acuity Lighting Group, Inc.
4. Lutron Electronics Co., Inc.
5. Sensor Switch, Inc.
6. Square D; a brand of Schneider Electric.
7. Watt Stopper.

B. General Description: Solid-state unit. The unit is designed to operate with the lamp and ballasts indicated.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Operation: Turn lights on when coverage area is occupied, and to half-power when unoccupied; with a time delay for turning lights to half-power that is adjustable over a minimum range of 1 to 16 minutes.
3. Continuous Lamp Monitoring: When lamps are dimmed continuously for 24 hours, automatically turn lamps on to full power for 15 minutes for every 24 hours of continuous dimming.
4. Operating Ambient Conditions: 32 to 149 deg F (0 to 65 deg C).
5. Mounting: Threaded pipe.

6. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
7. Detector Technology: PIR.
8. Power and dimming control from the lighting fixture ballast that has been modified to include the dimming capacitor and MyzerPORT option.

C. Detector Coverage: User selectable by interchangeable PIR lenses, suitable for mounting heights from 12 to 50 feet (3.7 to 15.2 m).

D. Accessories: Obtain manufacturer's installation and maintenance kit with laser alignment tool for sensor positioning and power port connectors.

2.7 OUTDOOR MOTION SENSORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
1. NSi Industries LLC; TORK Products.
2. Cooper Industries, Inc.
3. Hubbell Building Automation, Inc.
4. Leviton Mfg. Company Inc.
5. Lithonia Lighting; Acuity Lighting Group, Inc.
6. Watt Stopper.

B. Performance Requirements: Suitable for operation in ambient temperatures ranging from minus 40 to plus 130 deg F, rated as rain-tight according to UL 773A.
1. Operation: Turn lights on when sensing infrared energy changes between background and moving body in area of coverage; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
2. Mounting:
   a. Sensor: Suitable for mounting in any position on a standard outdoor junction box.
   b. Relay: Internally mounted in a standard weatherproof electrical enclosure.
   c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
3. Bypass Switch: Override the on function in case of sensor failure.
4. Automatic Light-Level Sensor: Adjustable from 1 to 20 fc; keep lighting off during daylight hours.

C. Detector Sensitivity: Detect occurrences of 6-inch- minimum movement of any portion of a human body that presents a target of not less than 36 sq. in.

D. Detection Coverage: Up to 35 feet, with a field of view of 180 degrees.

E. Lighting Fixture Mounted Sensor: Suitable for switching 300 W of tungsten load at 120- or 277-V ac.

F. Individually Mounted Sensor: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
1. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. The power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.

2. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.

2.8 LIGHTING CONTACTORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   1. Allen-Bradley/Rockwell Automation.
   2. ASCO Power Technologies, LP; a division of Emerson Electric Co.
   3. Eaton Electrical Inc.; Cutler-Hammer Products.
   4. GE Industrial Systems; Total Lighting Control.
   5. Grasslin Controls Corporation; a GE Industrial Systems Company.
   6. Hubbell Lighting.
   7. Square D; Schneider Electric.
   8. TORK.
   9. Watt Stopper (The).

B. Description: Electrically operated and mechanically held, combination-type lighting contactors with nonfused disconnect, complying with NEMA ICS 2 and UL 508.
   1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).
   2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
   3. Enclosure: Comply with NEMA 250.
   4. Provide control and pilot devices as scheduled, matching the NEMA type specified for the enclosure.

C. BAS Interface: Provide hardware interface to enable the BAS to monitor and control lighting contactors.
   1. Monitoring: On-off status.
   2. Control: On-off operation.

2.9 EMERGENCY SHUNT RELAY

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   1. Lighting Control and Design; Acuity Lighting Group, Inc.
   2. Watt Stopper.

B. Description: Normally closed, electrically held relay, arranged for wiring in parallel with manual or automatic switching contacts; complying with UL 924.
   1. Coil Rating: 120V.

2.10 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 SENSOR INSTALLATION

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.

B. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.2 CONTACTOR INSTALLATION

A. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.3 WIRING INSTALLATION

A. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch (13 mm).

B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

C. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.4 IDENTIFICATION

A. Identify components and power and control wiring according to Section 260553 "Identification for Electrical Systems."
   1. Identify controlled circuits in lighting contactors.
   2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.

B. Label time switches and contactors with a unique designation.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate lighting control devices and perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections[with the assistance of a factory-authorized service representative:
   1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
   2. Test and adjust controls and safety. Replace damaged and malfunctioning controls and equipment.

D. Lighting control devices will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.6 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to two visits to the Project during other-than-normal occupancy hours for this purpose.
   1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
   2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.
   3. Align high-bay occupancy sensors using manufacturer's laser aiming tool.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices. Refer to Division 01 Section "Project Closeout."

END OF SECTION 260923

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Related Sections include the following:
1. Division 26 Section 260573, "Power Systems Studies".
2. Division 26 Section 260553, "Electrical Identification" for identification materials.
3. Division 26 Section 262813, "Fuses".

1.2 DESCRIPTION OF WORK

A. Section Includes:

1. Distribution panelboards.
2. Branch-circuit panelboards.

1.3 SUBMITTALS

A. Shop Drawings -
1. Power Systems Studies specified in Section 260573, shall be completed and submitted prior to submitting shop drawings for this section.
2. For each panelboard and related equipment, provide:
   a. Dimensioned plans, elevations, sections, and details. Show schedules of installed devices, equipment features, and ratings. Overcurrent device order and phase assignment shall match those scheduled on Contract Documents.
   b. Enclosure types, material, environmental rating, and construction details.
   c. Bus, current, and voltage ratings.
   d. Short-circuit current rating of panelboards and overcurrent protective devices.
   e. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
   f. Wiring diagrams for power, signal, and control wiring, if present.
   g. Time-current coordination curves for each type and rating of overcurrent protective device included in panelboards.
   h. Additional information as required in Section 26 0001, "Basic Requirements for Electrical".

B. Closeout Submittal
1. Include final version of approved shop drawing submittals within the Operation and Maintenance manual.
2. Provide manufacturer's written instructions for testing and adjusting overcurrent protective devices.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. UL Standards: Panelboards and enclosures shall conform to all applicable UL standards and shall be UL-labeled.

E. Comply with NFPA 70.

F. Products shall be designed, manufactured, tested, and installed in compliance with the following standards:
   1. NEMA PB 1 Panelboards
   2. NEMA AB 1Molded Case Circuit Breakers
   3. NEMA KS 1 Enclosed Switches
   4. NEMA PB 1.1 Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.

1.5 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.

   1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. Enclosures: Refer to drawings and schedules for cabinet mounting requirements.
1. Distribution Panel Enclosures: Distribution panel enclosures shall be code gauge galvanized steel with wire bending space per the NEC. The distribution panel interior assembly shall be dead front with panel front removed. Main lugs or main circuit breakers shall have barriers on five sides. The barrier in front of the main lugs shall be hinged to a fixed part of the interior. The end of the bus structure opposite the mains shall have barriers. Interior surface distribution panels shall have full height front covers full height hinged to the distribution panel back box with fastening on the non-hinged side. Interior flush and exterior distribution panel fronts shall be full-height hinged door-in-door front covers with an interior access door hinged to the main front cover providing dead-front access to the panelboard overcurrent devices (interior) and the dead front main cover over the interior and wireway full-height hinged to the panelboard back box with concealed fastening on the non-hinged side. Cabinet interior doors shall be equipped with a latch and tumbler type lock. Doors over 48" long shall be equipped with a three point latch and vault lock with all distribution panel and panelboard locks keyed alike. Cabinets shall be of sufficient size to allow a width of gutter to conform with Underwriters' Laboratories, Inc. Standards. [Covers for panelboards installed in any areas subject to moisture shall be stainless steel.]
2. Panelboard Enclosures: Panelboard enclosures shall be code gauge galvanized steel with wire bending space per the NEC. Panelboard enclosures shall be minimum 16 gauge thickness, minimum 20" width, withoutknockouts, unless shown, scheduled or noted otherwise. Panelboard fronts shall be full-height hinged door-in- door front covers with an interior access door hinged to the main front cover providing dead- front access to the panelboard overcurrent devices (interior) and the dead front main cover over the interior and wireway full-height hinged to the panelboard back box with fastening, concealed on flush mounted panelboards, on the non-hinged side. Provide flush spring latch and keyed lock for all panelboard access doors with all distribution panel and panelboard locks keyed alike. Trim on flush mounted panels shall have concealed fasteners. [Covers for panelboards installed in any areas subject to moisture shall be stainless steel.] Enclosures shall be fabricated by the same manufacturer as panelboards to be enclosed. Multi-section panelboards shall have separate covers and trims. Multi-section panel cans shall be installed side by side with minimum 1" gap.
3. Provide cabinets rated for environmental conditions at locations indicated on the drawings. If not otherwise noted on the drawings or schedules, refer to the following:
a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
b. Outdoor Locations: NEMA 250, Type 3R.

c. Kitchen Areas: NEMA 250, Type 4X , stainless steel.
d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

4. Front: For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
5. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
6. Finishes:
   a. Panels and Trim: Galvanized steel, factory finished immediately after cleaning and pre-treating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
   b. Back Boxes: Galvanized steel.
   c. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.
7. Directory Card: Inside panelboard door, mounted in metal frame with transparent protective cover.

C. Incoming Mains Location: Coordinate a planned route for panelboard feeders prior to submittal. Provide mains at locations required by the panel location and feeder routing.

D. Phase, Neutral, and Ground Busses:
1. Material: Tin-plated aluminum or Hard-drawn copper, 98 percent conductivity.
2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
3. Provide Neutral Bus rated 200% of phase bus and UL listed as suitable for nonlinear loads where scheduled on drawings or if supplied by K-rated or phase cancellation transformers

E. Conductor Connectors: Suitable for use with conductor material and sizes.
1. Material: Tin-plated aluminum or Hard-drawn copper, 98 percent conductivity.
2. Main and Neutral Lugs: Compression type.
3. Ground Lugs and Bus-Configured Terminators: Mechanical type.
4. Feed-Through Lugs: Compression type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
5. Subfeed (Double) Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
6. Gutter-Tap Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
7. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.

F. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.

G. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

H. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.2 DISTRIBUTION PANELBOARDS

A. Panelboards: NEMA PB 1, power and feeder distribution type.

2.3 BRANCH-CIRCUIT PANELBOARD

A. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

2.4 OVERCURRENT PROTECTIVE DEVICES

A. Mains: Provide rating as scheduled

B. Common Requirements
1. All single-pole circuit breakers shall be either ambient or case-compensated (calibrated 40°C) thermal-magnetic type breakers, with inverse time delay on overloads and instantaneous magnetic trip on short circuits. (Twin, tandem and half-size single-pole breakers and breaker tie handles are not acceptable.) All multiple breakers shall be common trip, thermal-magnetic type, calibrated 40°C.
2. Breakers shall employ quick-make, toggle mechanism for manual operation, as well as automatic operation. The breakers shall have provisions for manually testing the tripping mechanism with the breaker removed from the panel. Automatic tripping shall be indicated by the breaker handle assuming a clearly distinctive position from the manual "on" and "off" positions.
3. Circuit breakers used as switches in 120 volt and 277 volt fluorescent lighting circuits, the circuit breakers shall be approved for such switching duty and shall be marked "SWD".
4. Provide panelboard circuit breakers with conventional interrupting capacity unless scheduled shown or noted otherwise, but in no case less than the following symmetrical amperes RMS:
   Voltage (volts) Interrupting Capacity
   120/208 10,000 AIC
   277/480 14,000 AIC
5. [Where “series rated” breakers are shown, scheduled or specified and the manufacturer does not have a series rated breaker combination for the application shown, fully rated breakers with the required minimum interrupting capacity shall be provided.]

C. Mounting:
1. The front faces of all circuit breakers shall be flush with each other.
2. Tripped indication shall be clearly shown by the breaker handle taking a position between "ON" and "OFF".
3. Provisions for additional breakers shall be such that no additional connectors will be required to add breakers.
4. Circuit breakers shall bolt in to the main bus for 480/277 volt panels (except Square D I-line panels which shall have plug-in breakers) and [bolt] [plug-in] on to the main bus for 208/120 volt panels.
5. All 2 and 3-pole breakers shall have common trips.
6. Circuit breakers shall be replaceable without disturbing adjacent units. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.

7. Multi-pole units enclosed in a single housing or factory assembled to operate as a single unit.
8. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in or off position.
9. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

D. Molded-Case Circuit Breaker (MCCB):
1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
3. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
4. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
   a. Standard frame sizes, trip ratings, and number of poles.
   b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
   c. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.

E. Solid State Trip Unit Circuit Breakers:
1. Distribution panel circuit breakers [400 ampere frame and above and all emergency power system distribution panel circuit breakers] shall be equipped with solid-state programmable trip complete with built-in current transformers, solid-state trip unit and flux transfer shunt trip. The solid-state electronic programmable trip device shall have the following features and tripping functions:
   a. Adjustable current setting
   b. Adjustable long-time delay
   c. Adjustable instantaneous pick-up
   d. Adjustable short time delay
   e. Adjustable short time pick-up
   f. [Adjustable ground fault delay]
   g. [Adjustable ground fault pick-up]

F. Current limiting thermal-magnetic circuit breakers suitable for interrupting currents up to 200,000 amperes shall be provided where scheduled or specified. Current limiting breakers shall have a non-fusible type independently operating limiter section in series with each pole which shall automatically reset after circuit interruption. Current limiting circuit breakers shall be equal to Square D Company "I-LIMITER".

G. Fused Switch: Fusible switches shall be quick-make quick-break type. Each switch shall be enclosed in a separate steel enclosure. The enclosure shall employ a hinged cover for access to the fuses. Cover shall be interlocked with the operating handle to prevent opening the cover when the switch is in the "ON" position. This interlock shall be constructed so that it can be over-ridden for testing fuses without interrupting service. The switches shall have padlocking provisions in the "OFF" position. Switches shall include positive pressure rejection type fuse clips for use with UL Class R fuses and be UL-

labeled for 200,000 AIC.NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.

1. Fuses, and Spare-Fuse Cabinet: Comply with requirements specified in Section 262813 "Fuses."

PART 3 - EXECUTION - Refer to Division 26 specification section for characteristics for surge protective devices.

3.1 DELIVERY, STORAGE, AND HANDLING

A. Do not deliver or install panelboard interiors until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

B. Deliver distribution panels and panelboards in factory-fabricated water-resistant wrapping.

C. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.

D. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation, unless stored in dried-in, conditioned space.

E. Handle panelboards carefully to avoid damage to material component, enclosure and finish.

F. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

G. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. Mount top of trim 90 inches (2286 mm) above finished floor unless otherwise indicated.

B. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

C. Install overcurrent protective devices and controllers not already factory installed.
1. Set field-adjustable, circuit-breaker trip ranges.

D. Install filler plates in unused spaces.

E. Stub four 1-inch (27-GRC) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch (27-GRC) empty conduits into raised floor space or below slab not on grade.

F. Arrange conductors in gutters into groups and bundle and wrap with wire ties after testing for load balance.

G. Comply with NECA 1.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 specification section for identifying electrical systems.

B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with Division 26 specification section for identifying electrical systems.

D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with Division 26 specification section for identifying electrical systems.

3.4 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. Test continuity of each circuit.
   2. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
   3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   4. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
   5. Perform the following infrared scan tests and inspections and prepare reports:
      a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
      b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
      c. Instruments and Equipment:
         1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

B. Panelboards will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 specification section for the overcurrent protective device coordination study."

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.
   1. Measure as directed during period of normal system loading.
   2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
   3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
   4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

END OF SECTION 262416

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Receptacles, receptacles with integral GFCI, and associated device plates.
2. Twist-locking receptacles.
3. Receptacles with integral surge-suppression units.
4. Isolated-ground receptacles.
5. Hospital-grade receptacles.
6. Tamper-resistant receptacles.
7. Weather-resistant receptacles.
8. Snap switches and wall-box dimmers.
9. Solid-state fan speed controls.
10. Wall-switch and exterior occupancy sensors.
11. Communications outlets.
12. Pendant cord-connector devices.
13. Cord and plug sets.
14. Floor service outlets, poke-through assemblies, service poles, and multioutlet assemblies.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GFCI: Ground-fault circuit interrupter.

C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

D. RFI: Radio-frequency interference.

E. SPD: Surge Protective Device.

F. UTP: Unshielded twisted pair.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Receptacles for Owner-Furnished Equipment: Match plug configurations.
2. Cord and Plug Sets: Match equipment requirements.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

C. Samples: One for each type of device and wall plate specified, in each color specified.

1.6 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
1. Cooper Wiring Devices; Division of Cooper Industries, Inc. (Cooper).
2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
3. Leviton Mfg. Company Inc. (Leviton).
4. Pass & Seymour/Legrand (Pass & Seymour).
5. <Insert manufacturer's name>.

B. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 GENERAL WIRING-DEVICE REQUIREMENTS

A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

C. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:
1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
2. Devices shall comply with the requirements in this Section.

2.3 STRAIGHT-BLADE RECEPTACLES

A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
   1. Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:
      a. Cooper; 5351 (single), CR5362 (duplex).
      b. Hubbell; HBL5351 (single), HBL5352 (duplex).
      c. Leviton; 5891 (single), 5352 (duplex).
      d. Pass & Seymour; 5361 (single), 5362 (duplex).
      e. <Insert manufacturer's name; catalog number(s)>.

B. Tamper-Resistant Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498 Supplement sd, and FS W-C-596.
   1. Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:
      a. Cooper; TR8300.
      b. Hubbell; DR15WHITR.
      c. Leviton; 8300-SGG.
      d. Pass & Seymour; TR63H.
   2. Description: Labeled shall comply with NFPA 70, "Health Care Facilities" Article, "Pediatric Locations" Section.

2.4 GFCI RECEPTACLES

A. General Description:
   1. Straight blade, non-feed-through type.
   2. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.
   3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.

B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Cooper; VGF20.
      b. Hubbell; GFR5352L.
      c. Pass & Seymour; 2095.
      d. Leviton; 7590.

C. Tamper-Resistant GFCI Convenience Receptacles, 125 V, 20 A:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Hubbell; GFTR20.
      b. Pass & Seymour; 2095TR.

D. Hospital-Grade, Duplex GFCI Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498 Supplement sd, and FS W-C-596.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Cooper; VGFH20.
      b. Hubbell; HFR8300HL.
      c. Leviton; 7899-HG.
      d. Pass & Seymour; 2095HG.

2.5 SPD RECEPTACLES

A. General Description: Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 1449, and FS W-C-596, with integral TVSS in line to ground, line to neutral, and neutral to ground.
   1. SPD Components: Multiple metal-oxide varistors; with a nominal clamp-level rating of 400 V and minimum single transient pulse energy dissipation of 240 J, according to IEEE C62.41.2 and IEEE C62.45.
   2. Active TVSS Indication: Visual and audible, with light visible in face of device to indicate device is "active" or "no longer in service."

B. Duplex SPD Convenience Receptacles:
   1. Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:
      a. Cooper; 5362BLS.
      b. Hubbell; HBL5362SA.
      c. Leviton; 5380.
      d. Pass & Seymour; 5362BLSP.
   2. Description: Straight blade, 125 V, 20 A; NEMA WD 6 Configuration 5-20R.

2.6 TWIST-LOCKING RECEPTACLES

A. Single Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration L5-20R, and UL 498.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Cooper; CWL520R.
      b. Hubbell; HBL2310.
      c. Leviton; 2310.
      d. Pass & Seymour; L520-R.

2.7 PENDANT CORD-CONNECTOR DEVICES

A. Description:
   1. Matching, locking-type plug and receptacle body connector.
   2. NEMA WD 6 Configurations L5-20P and L5-20R, heavy-duty grade, and FS W-C-596.
   3. Body: Nylon, with screw-open, cable-gripping jaws and provision for attaching external cable grip.
   4. External Cable Grip: Woven wire-mesh type made of high-strength, galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2.8 CORD AND PLUG SETS

A. Description:
   1. Match voltage and current ratings and number of conductors to requirements of equipment being connected.
   2. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and ampacity of at least 130 percent of the equipment rating.

3. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.9 TOGGLE SWITCHES

A. Comply with NEMA WD 1, UL 20, and FS W-S-896.

B. Switches, 120/277 V, 20 A:
1. Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:
1) Single Pole:
a) Cooper; AH1221.
b) Hubbell; HBL1221.
c) Leviton; 1221-2.
d) Pass & Seymour; CSB20AC1.
2) Two Pole:
a) Cooper; AH1222.
b) Hubbell; HBL1222.
c) Leviton; 1222-2.
d) Pass & Seymour; CSB20AC2.
3) Three Way:
a) Cooper; AH1223.
b) Hubbell; HBL1223.
c) Leviton; 1223-2.
d) Pass & Seymour; CSB20AC3.
4) Four Way:
a) Cooper; AH1224.
b) Hubbell; HBL1224.
c) Leviton; 1224-2.
d) Pass & Seymour; CSB20AC4.

C. Pilot-Light Switches, 20 A:
1. Products: Subject to compliance with requirements, provide one of the following:
a. Cooper; AH1221PL for 120 and 277 V.
b. Hubbell; HBL1201PL for 120 and 277 V.
c. Leviton; 1221-LH1.
d. Pass & Seymour; PS20AC1RPL for 120 V, PS20AC1RPL7 for 277 V.
2. Description: Single pole, with neon-lighted handle, illuminated when switch is "off."

D. Key-Operated Switches, 120/277 V, 20 A:
1. Products: Subject to compliance with requirements, provide one of the following:
a. Cooper; AH1221L.
b. Hubbell; HBL1221L.
c. Leviton; 1221-2L.
d. Pass & Seymour; PS20AC1-L.
2. Description: Single pole, with factory-supplied key in lieu of switch handle.

E. Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches: 120/277 V, 20 A; for use with mechanically held lighting contactors.
1. Products: Subject to compliance with requirements, provide one of the following:

a. Cooper; 1995.
b. Hubbell; HBL1557.
c. Leviton; 1257.
d. Pass & Seymour; 1251.

F. Key-Operated, Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches: 120/277 V, 20 A; for use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle.
1. Products: Subject to compliance with requirements, provide one of the following:
a. Cooper; 1995L.
b. Hubbell; HBL1557L.
c. Leviton; 1257L.
d. Pass & Seymour; 1251L.

2.10 DECORATOR-STYLE DEVICES

A. Convenience Receptacles: Square face, 125 V, 15 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-15R, and UL 498.
1. Products: Subject to compliance with requirements, provide one of the following:
a. Cooper; 6252.
b. Hubbell; DR15.
c. Leviton; 16252.
d. Pass & Seymour; 26252.

B. Tamper-Resistant Convenience Receptacles: Square face, 125 V, 15 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-15R, and UL 498.
1. Products: Subject to compliance with requirements, provide one of the following:
a. Cooper; TR6252.
b. Hubbell; DR15TR.
c. Pass & Seymour; TR26252.

2. Description: Labeled to comply with NFPA 70, "Receptacles, Cord Connectors, and Attachment Plugs (Caps)" Article, "Tamper-Resistant Receptacles in Dwelling Units" Section.

C. Tamper-Resistant and Weather-Resistant Convenience Receptacles: Square face, 125 V, 15 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-15R, and UL 498.
1. Products: Subject to compliance with requirements, provide one of the following:
a. Cooper; TWRBR15.
b. Hubbell; DR15TR.
c. LevitonTRW15.
d. Pass & Seymour; TRW26252.
2. Description: Labeled to comply with NFPA 70, "Receptacles, Cord Connectors, and Attachment Plugs (Caps)" Article, "Tamper-Resistant Receptacles in Dwelling Units" Section, when installed in wet and damp locations.

D. GFCI, Feed-Through Type, Convenience Receptacles: Square face, 125 V, 15 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-15R, UL 498, and UL 943 Class A.
1. Products: Subject to compliance with requirements, provide one of the following:
a. Cooper; VGF15.
b. Hubbell; GF15LA.
c. Leviton; 8599.

d. Pass & Seymour; 1594.

E. GFCI, Tamper-Resistant and Weather-Resistant Convenience Receptacles: Square face, 125 V, 15 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-15R, UL 498, and UL 943 Class A.
1. Products: Subject to compliance with requirements, provide one of the following:
a. Cooper; TWRVGF15.
b. Hubbell; GFTR15.
c. Pass & Seymour; 1594TRWR.
2. Description: Labeled to comply with NFPA 70, "Receptacles, Cord Connectors, and Attachment Plugs (Caps)" Article, "Tamper-Resistant Receptacles in Dwelling Units" Section.

F. Toggle Switches, Square Face, 120/277 V, 15 A: Comply with NEMA WD 1, UL 20, and FS W-S-896.
1. Products: Subject to compliance with requirements, provide one of the following:
a. Cooper; 7621 (single pole), 7623 (three way).
b. Hubbell; DS115 (single pole), DS315 (three way).
c. Leviton; 5621-2 (single pole), 5623-2 (three way).
d. Pass & Seymour; 2621 (single pole), 2623 (three way).

G. Lighted Toggle Switches, Square Face, 120 V, 15 A: Comply with NEMA WD 1 and UL 20.
1. Products: Subject to compliance with requirements, provide one of the following:
a. Cooper; 7631 (single pole), 7633 (three way).
b. Hubbell; DS120IL (single pole), DS320 (three way).
c. Leviton; 5631-2 (single pole), 5633-2 (three way).
d. Pass & Seymour; 2625 (single pole), 2626 (three way).
2. Description: With neon-lighted handle, illuminated when switch is "off."

2.11 WALL-BOX DIMMERS

A. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.

B. Control: Continuously adjustable slider; with single-pole or three-way switching. Comply with UL 1472.

2.12 WALL PLATES

A. Single and combination types shall match corresponding wiring devices.
1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces: [Steel with white baked enamel, suitable for field painting] [Smooth, high-impact thermoplastic] [0.035-inch- (1-mm-) thick, satin-finished, Type 302 stainless steel] [0.04-inch- (1-mm-) thick, brushed brass with factory polymer finish] [0.05-inch- (1.2-mm-) thick, anodized aluminum] [0.04-inch- (1-mm-) thick steel with chrome-plated finish].
3. Material for Unfinished Spaces: [Galvanized steel] [Smooth, high-impact thermoplastic].
4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable cover.

2.13 FINISHES

A. Device Color:
1. Wiring Devices Connected to Normal Power System: As selected by Architect, unless otherwise indicated or required by NFPA 70 or device listing.
2. Wiring Devices Connected to Emergency Power System: Red.
3. SPD Devices: Blue.

B. Wall Plate Color: For plastic covers, match device color.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.

B. Coordination with Other Trades:
1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:
1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:
   a. Cut back and pigtail, or replace all damaged conductors.
   b. Straighten conductors that remain and remove corrosion and foreign matter.
   c. Pigtailing existing conductors is permitted, provided the outlet box is large enough.

D. Device Installation:
1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.

3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches (152 mm) in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:
1. Install ground pin of vertically mounted receptacles [up] [down], and on horizontally mounted receptacles to the [right] [left].
2. Install hospital-grade receptacles in patient-care areas with the ground pin or neutral blade at the top.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Dimmers:
1. Install dimmers within terms of their listing.
2. Verify that dimmers used for fan speed control are listed for that application.
3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.

H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 GFCI RECEPTACLES

A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

3.3 IDENTIFICATION

A. Comply with Section 260553 "Identification for Electrical Systems."

B. Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with [black] [white] [red]-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.4 FIELD QUALITY CONTROL

A. Tests for Convenience Receptacles:
   1. Line Voltage: Acceptable range is 105 to 132 V.
   2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
   3. Ground Impedance: Values of up to 2 ohms are acceptable.
   4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
   5. Using the test plug, verify that the device and its outlet box are securely mounted.
   6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

B. Wiring device will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION 262726

SECTION 262813 - FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DESCRIPTION OF WORK

A. Section Includes:
1. Cartridge fuses rated 600-V ac and less for use in control circuits, enclosed switches, and enclosed controllers.

1.3 ACTION SUBMITTALS

A. Shop Drawing submittals shall include, but not be limited to, the following:
1. Product Data: For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:
a. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
1) For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
2) Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
b. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
c. Current-limitation curves for fuses with current-limiting characteristics.
d. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
e. Coordination charts and tables and related data.
f. Fuse sizes for elevator feeders and elevator disconnect switches.

B. Closeout Submittal
1. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
2. Ambient temperature adjustment information.

1.4 SPARE MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NEMA FU 1 for cartridge fuses.

D. Comply with NFPA 70.

E. Comply with UL 248-11 for plug fuses.

1.6 PROJECT CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F (5 deg C) or more than 100 deg F (38 deg C) , apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.7 COORDINATION

A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide one of the following:
   1. Cooper Bussmann, Inc.
   2. Edison Fuse, Inc.
   3. Ferraz Shawmut, Inc.
   4. Littelfuse, Inc.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

3.2 FUSE APPLICATIONS

A. Cartridge Fuses:
1. Service Entrance: Class L, time delay.
2. Feeders: Class RK5, time delay
3. Motor Branch Circuits: Class RK1 or Class RK5, time delay.
4. Control Circuits: Class CC

3.3 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

3.4 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 262813

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 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 DESCRIPTION OF WORK

A. Section Includes:
1. Fusible switches.
2. Non-fusible switches.
3. Shunt trip switches.
4. Enclosures.

1.3 DEFINITIONS

A. NC: Normally closed.

B. NO: Normally open.

C. SPDT: Single pole, double throw.

1.4 SUBMITTALS

A. Shop Drawings: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.
3. Short-circuit current ratings (interrupting and withstand, as appropriate).
4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
5. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

B. Closeout Submittals:
1. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
a. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.

b. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Comply with NFPA 70.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
1. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).
2. Altitude: Not exceeding 6600 feet (2010 m).

1.7 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide one of the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.
5. Cooper Industries; Bussman

B. Type HD, Heavy Duty, Single Throw, 240V ac, 400 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Type HD, Heavy Duty, Six Pole, Single Throw, 600-V ac, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

D. Type HD, Heavy Duty, Double Throw, 240V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

E. Accessories:
1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
4. Lugs: Compression type, suitable for number, size, and conductor material.
5. Service-Rated Switches: Labeled for use as service equipment.
6. Accessory Control Power Voltage: Remote mounted and powered; 120V ac, unless otherwise indicated.

2.2 NON-FUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide one of the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.
5. Cooper Industries; Bussman

B. Type HD, Heavy Duty, Single Throw, 240V ac, 400 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Type HD, Heavy Duty, Six Pole, Single Throw, 600-V ac, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

D. Type HD, Heavy Duty, Double Throw, 240V ac, 400 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

E. Accessories:
1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
4. Lugs: Compression type, suitable for number, size, and conductor material.

5. Accessory Control Power Voltage: Remote mounted and powered; 120V ac, unless otherwise indicated.

2.3 MOLDED-CASE CIRCUIT BREAKERS

A. Manufacturers: Subject to compliance with requirements, provide one of the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.

C. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

D. Features and Accessories:
1. Standard frame sizes, trip ratings, and number of poles.
2. Lugs: Compression type, suitable for number, size, trip ratings, and conductor material.

2.4 MOLDED-CASE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide one of the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. General Requirements: MCCB with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.

C. Features and Accessories:
1. Standard frame sizes and number of poles.
2. Lugs: Compression type, suitable for number, size, trip ratings, and conductor material.

2.5 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
1. Indoor, Dry and Clean Locations: NEMA 250, Type 1 .
2. Outdoor Locations: NEMA 250, Type 3R .
3. Kitchen Wash-Down Areas: NEMA 250, Type 4X , stainless steel.
4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4 .
5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

3.2 INSTALLATION

A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

C. Install fuses in fusible devices.

D. Comply with NECA 1.

3.3 IDENTIFICATION

A. Comply with requirements in Section 260553 "Identification for Electrical Systems."
   1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
   2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Acceptance Testing Preparation:
   1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

C. Tests and Inspections:
   1. Refer to testing requirements specified in Section 260001 "Basic Requirements for Electrical"

D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573 "Overcurrent Protective Device Coordination Study."

END OF SECTION 262816

SECTION 263213 - ENGINE GENERATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes packaged engine-generator sets for emergency power supply with the following features:
   1. Diesel engine.
   2. Unit-mounted cooling system.
   3. Remote-mounting control and monitoring.
   4. Sub tank fuel base.

B. Related Sections and Drawings include the entire document set. Specific Sections and Drawings include, but are not limited by, the following:
   1. Section 263600 "Automatic Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine-generator sets.
   2. Electrical one-line diagrams.

C. The generator shall consist of a liquid cooled diesel engine, an AC alternator, and system controls with all necessary accessories for a complete operating system, including but not limited to the items as specified hereinafter.

D. The generator system, including controls and the following components shall include the following components packaged and supplied as a functional system from the generator manufacturer/vendor:
   1. Automatic Transfer Switch (ATS)
   2. Temporary Generator Docking Station, with connection for load bank testing.
   3. See One-Line Diagram, Drawing Sheet E4.1

E. The generator shall be able to operate on diesel fuel.

F. The generator shall be equipped with sub base fuel tank with capacity for operation of generator as indicated following in fuel oil storage paragraph.

G. The generator will be provided with sound attenuated, weatherproof enclosure.

H. The genset shall be suited for local ambience and elevation. Genset's sound level in dBA at 23 ft based on the configuration specified.

I. Requirements of Regulatory Agencies
   1. An electric generating system, consisting of a prime mover, generator, governor, coupling and all controls, must have been tested, as a complete unit, on a representative engineering prototype model of the equipment to be sold.
   2. The generator set must conform to applicable NFPA requirements.

3. The generator set must include a listing for the UL2200 standard for stationary engine generator assembly.
4. The generator must meet EPA federal emission guidelines for stationary emergency power generation in diesel mode of operation. This compliance must be factory verified using a 5 mode EPA test in an EPA certified test cell.

1.3 DEFINITIONS

A. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of packaged engine generator and paralleling system as indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. In addition, include the following:
1. Thermal damage curve for generator.
2. Time-current characteristic curves for generator protective device(s)

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
1. Dimensioned outline plan and elevation drawings of engine-generator set and other components specified.
2. Design Calculations: Signed and sealed by a qualified professional engineer. Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
3. Vibration Isolation Base Details: Signed and sealed by a qualified professional engineer. Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include base weights.
4. Wiring Diagrams: Power, signal, and control wiring.

C. Submit a sequence of operations. Submit wiring diagrams indicating power and control interconnect wiring between generator and ATSs.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For installer, manufacturer and testing agency.

B. Source quality-control test reports.
1. Certified summary of prototype-unit test report.
2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
3. Certified Summary of Performance Tests: Certify compliance with specified requirement to meet performance criteria for sensitive loads.
4. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
5. Report of sound generation.
6. Report of exhaust emissions showing compliance with applicable regulations.
7. Certified Torsional Vibration Compatibility: Comply with NFPA 110.

C. Field quality-control test reports.

D. Warranty: Special warranty specified in this Section.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals. In addition to items specified in general specification requirements for "Operation and Maintenance Data," include the following:
   1. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fuses: One for every 10 of each type and rating, but no fewer than one of each.
   2. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.
   3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
   1. Maintenance Proximity: Not more than three hours normal travel time from Installer's place of business to Project site.
   2. Engineering Responsibility: Preparation of data for vibration isolators and seismic restraints of engine skid mounts, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.

B. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 200 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.

C. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL), and that is acceptable to authorities having jurisdiction.
   1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

D. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

F. Comply with ASME B15.1.

G. Comply with NFPA 37.

H. Comply with NFPA 70.

I. Comply with NFPA 110 requirements for emergency power supply system.

J. Comply with UL 2200.

K. Engine Exhaust Emissions: Comply with applicable state and local government requirements.

L. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

1.9 PROJECT CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
1. Owner's written permission is required for any and all outages of electrical power at the facility. This permission must be acquired by the Contractor prior to the outage(s).
2. Contractor shall provide a project schedule indicating all proposed outages of electrical power, and the durations of such outages as part of the Contractor's required submittals, prior to mobilization on the project.
3. The Contractor's proposed outages shall be considered as a request for Owner's permission for the outages.
4. written permission from Owner no fewer than two days in advance of proposed interruption of electrical service.
5. Do not proceed with interruption of electrical service without Owner's written permission.

B. Environmental Conditions: Engine-generator system shall withstand and operate properly in the environmental conditions expected at the indicated project site location, without mechanical or electrical damage or degradation of performance capability. The maximum range for the satisfactory equipment shall be indicated as part of the Contractor's submittal data required prior to procurement of the equipment. Contractor shall state maximum range for the proposed generator as indicated below:
1. Ambient Temperature range: _____
2. Relative Humidity range: _____
3. Altitude range: _____

1.10 COORDINATION

A. Coordinate size and location of concrete bases for package engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.11 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Five years from date of Substantial Completion.

1.12 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, provide 12 months full maintenance by skilled employees of manufacturer's designated service organization. Include quarterly exercises to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Caterpillar; Engine Div.
   2. Generac Power Systems, Inc.
   3. Kohler Co.; Generator Division.
   4. Magnetek, Inc.
   5. Onan/Cummins Power Generation; Industrial Business Group.
   6. Approved Equal. See substitution requirements in specifications.

2.2 ENGINE-GENERATOR SET

A. Factory-assembled and tested, engine-generator set.

B. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.
   1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and generator-set center of gravity.

C. Capacities and Characteristics:
   1. Power Output Ratings: Nominal ratings as indicated.
   2. Output Connections: As indicated on one-line diagrams.
   3. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.

D. Generator-Set Performance:
   1. Steady-State Voltage Operational Bandwidth: 3 percent of rated output voltage from no load to full load.
   2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.

3. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
5. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.
6. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
7. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.
8. Start Time: Comply with NFPA 110, Type 10, system requirements.

E. Generator-Set Performance for Sensitive Loads:
1. Oversizing generator compared with the rated power output of the engine is permissible to meet specified performance.
   a. Nameplate Data for Oversized Generator: Show ratings required by the Contract Documents rather than ratings that would normally be applied to generator size installed.
2. Steady-State Voltage Operational Bandwidth: 1 percent of rated output voltage from no load to full load.
3. Transient Voltage Performance: Not more than 10 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 0.5 second.
4. Steady-State Frequency Operational Bandwidth: Plus or minus 0.25 percent of rated frequency from no load to full load.
5. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
6. Transient Frequency Performance: Less than 2-Hz variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within three seconds.
7. Output Waveform: At no load, harmonic content measured line to neutral shall not exceed 2 percent total with no slot ripple. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
8. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to winding insulation or other generator system components.
9. Excitation System: Performance shall be unaffected by voltage distortion caused by nonlinear load.
   a. Provide permanent magnet excitation for power source to voltage regulator.
10. Start Time: Comply with NFPA 110, Type 10, system requirements.

2.3 ENGINE

A. Fuel: Fuel oil, Grade DF-2

B. Rated Engine Speed: 1800 rpm.

C. Maximum Piston Speed for Four-Cycle Engines: 2250 fpm (11.4 m/s).

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

E. The prime mover shall be a liquid cooled, diesel fueled, engine of 4-cycle design. It will have adequate horsepower to achieve rated kW output at an operating speed of 1800 RPM.

F. The engine shall support a 100% load step.

G. The system shall be sized and sequenced to allow emergency system loads as defined by NEC 700 to be transferred onto the generator(s) within 10 seconds.

H. Engine Fuel System:
   1. Main Fuel Pump: Mounted on engine. Pump ensures adequate primary fuel flow under starting and load conditions.
   2. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.

I. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity.

J. Governor: Adjustable isochronous, with speed sensing.

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

L. Muffler/Silencer: Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.
   1. Minimum sound attenuation of 25 dB at 500 Hz.
   2. Sound level measured at a distance of 10 feet from exhaust discharge after installation is complete shall be 85 dBA or less.

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

N. Starting System: 24-V electric, with negative ground.
   1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article.
   2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
   3. Cranking Cycle: As required by NFPA 110 for system level specified.
   4. Battery: Adequate capacity within ambient temperature range specified in Part 1 "Project Conditions" Article to provide specified cranking cycle at least twice without recharging.
   5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
   6. Battery Compartment: Factory fabricated metal with acid-resistant finish and thermal insulation. Thermostatically controlled heaters shall be arranged to maintain battery above 10 deg C regardless of external ambient temperature within range specified in Part 1 "Project Conditions" Article. Include accessories required to support and fasten batteries in place.
   7. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.
   8. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit shall comply with UL 1236 and include the following features:
      a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
      b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg C to plus 60 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.
      c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
      d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
      e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
      f. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

2.4 FUEL OIL STORAGE

A. Comply with NFPA 30.

B. Base-Mounted Fuel Oil Tank: Factory installed and piped, complying with UL 142 fuel oil tank. Features include the following:
1. Tank level indicator.
2. Capacity: Fuel for forty eight (48) hours continuous operation at 100 percent rated power output.
3. Vandal-resistant fill cap.
4. Containment Provisions: Comply with requirements of authorities having jurisdiction.

2.5 CONTROL AND MONITORING

A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When mode-selector switch is switched to the on position, generator set starts. The off position of the same switch initiates generator-set shutdown. When the generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down the generator set.

B. Manual Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position starts generator set. The off position of the same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down the generator set.

C. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the generator set. The mounting method shall isolate the control panel from generator-set vibration.

D. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common wall-mounted control and monitoring panel.

E. Indicating and Protective Devices and Controls: As required by NFPA 110 for Level 1 system, and the following:
1. AC voltmeter.
2. AC ammeter.
3. AC frequency meter.
4. DC voltmeter (alternator battery charging).
5. Engine-coolant temperature gage.
6. Engine lubricating-oil pressure gage.
7. Running-time meter.
8. Ammeter-voltmeter, phase-selector switch(es).
9. Generator-voltage adjusting rheostat.
10. Fuel tank derangement alarm.
11. Fuel tank high-level shutdown of fuel supply alarm.

12. Generator overload.

F. Indicating and Protective Devices and Controls:
1. AC voltmeter.
2. AC ammeter.
3. AC frequency meter.
4. DC voltmeter (alternator battery charging).
5. Engine-coolant temperature gage.
6. Engine lubricating-oil pressure gage.
7. Running-time meter.
8. Ammeter-voltmeter, phase-selector switch(es).
9. Generator-voltage adjusting rheostat.
10. Start-stop switch.
11. Overspeed shutdown device.
12. Coolant high-temperature shutdown device.
13. Coolant low-level shutdown device.
14. Oil low-pressure shutdown device.
15. Fuel tank derangement alarm.
16. Fuel tank high-level shutdown of fuel supply alarm.
17. Generator overload.

G. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.

H. Connection to Data Link: A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication is reserved for connections for data-link transmission of indications to remote data terminals. Data system connections to terminals are covered in Section 260913 "Electrical Power Monitoring and Control."

I. Common Remote Audible Alarm: Comply with NFPA 110 requirements for Level 1 systems. Include necessary contacts and terminals in control and monitoring panel.
1. Overcrank shutdown.
2. Coolant low-temperature alarm.
3. Control switch not in auto position.
4. Battery-charger malfunction alarm.
5. Battery low-voltage alarm.

J. Common Remote Audible Alarm: Signal the occurrence of any events listed below without differentiating between event types. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset.
1. Engine high-temperature shutdown.
2. Lube-oil, low-pressure shutdown.
3. Overspeed shutdown.
4. Remote emergency-stop shutdown.
5. Engine high-temperature prealarm.
6. Lube-oil, low-pressure prealarm.
7. Fuel tank, low-fuel level.
8. Low coolant level.

K. Remote Alarm Annunciator: Comply with NFPA 99. An LED labeled with proper alarm conditions shall identify each alarm event and a common audible signal shall sound for

each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.

L. Remote Emergency-Stop Switch: Flush; wall mounted, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.

2.6 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Generator Output Circuit Breakers: Molded-case, electronic-trip type; 100 percent rated; complying with UL 489.
1. Tripping Characteristics: Adjustable long-time and short-time delay and instantaneous.
2. Trip Settings: Selected to coordinate with generator thermal damage curve.
3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
4. Mounting: Adjacent to or integrated with control and monitoring panel.

B. Generator Disconnect Switch(s): Molded-case type, 100 percent rated.
1. Rating: Matched to generator output rating.
2. Shunt Trip: Connected to trip switch when signaled by generator protector or by other protective devices.

C. Generator Protector: Microprocessor-based unit shall continuously monitor current level in each phase of generator output, integrate generator heating effect over time, and predict when thermal damage of alternator will occur. When signaled by generator protector or other generator-set protective devices, a shunt-trip device in the generator disconnect switch shall open the switch to disconnect the generator from load circuits. Protector shall perform the following functions:
1. Initiates a generator overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other generator-set malfunction alarms.
2. Under single or three-phase fault conditions, regulates generator to 300 percent of rated full-load current for up to 10 seconds.
3. As overcurrent heating effect on the generator approaches the thermal damage point of the unit, protector switches the excitation system off, opens the generator disconnect device, and shuts down the generator set.
4. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot.

D. Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground-fault. Integrate ground-fault alarm indication with other generator-set alarm indications.

2.7 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

A. Comply with NEMA MG 1.

B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.

C. Electrical Insulation: Class H or Class F.

D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.

E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.

F. Enclosure: Dripproof.

G. Instrument Transformers: Mounted within generator enclosure.

H. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.

I. Adjusting rheostat on control and monitoring panel shall provide plus or minus 5 percent adjustment of output-voltage operating band.

J. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.

K. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

L. Subtransient Reactance: 12 percent, maximum.

2.8 Paralleling System Controller

A. The system controller shall be an integrated microprocessor based solution providing full digital integration with the generator controllers. The system controller shall utilize standard hardware and firmware manufactured by the generator supplier. The use of PLC based solutions will be considered less desirable due to reliability and support concerns posed by custom hardware/custom software solutions. A preference will be shown for designs that use the same control board hardware for both the generator(s) and system controller.

B. To ensure reliability and serviceability, the system controller shall be required to meet the same requirements as listed for the generator controller in sections 4.1.3 to 4.1.7 and 4.1.10.

C. The control panel will provide a touch screen display to provide intuitive access to all user pertinent system status information. The power for the system controller shall utilize redundant DC sources - an internal DC source inclusive of charging system and an external DC source from one of the generator's cranking batteries.

D. The system controller shall interface with the generators using digital communications. Any of the generator(s) status, operation conditions, or configuration parameters shall be accessible with a single point communication via the system controller.

E. The system controller shall provide sequence of facility load through 1 priority loading (permissive) load step and 1 load shedding step. The priority loading function provides sequential permissive contact closures enabling load to be transferred onto the generator in response to load on the generator. The load shedding function provides contact closures that disconnects load from the generator bus in response to a reduction in available generator capacity.

F. Communications shall be supported with building automation via the Modbus protocol without network cards. Optional internet and intranet connectivity shall be available.

H. load2.10 Normal Operating Sequence

A. Upon the failure of utility power, the automatic transfer switch(es) (ATS) provides a two-wire start signal to the system controller.

A. Transfer switch(es) supplied shall be capable of being inhibited from transferring with a contact from the system controller. The transfer switches supplied shall also be able to shed load via trip-to-neutral feature -- the load is shed and does not re-close to a utility that may have a fault present.

2.11 VIBRATION ISOLATION DEVICES

A. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized-steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.
1. Material: Standard neoprene.
2. Durometer Rating: 60.
3. Number of Layers: Three.

2.12 FINISHES

A. Indoor enclosures and indoor and outdoor components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

2.13 SOURCE QUALITY CONTROL

A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.
1. Tests: Comply with NFPA 110, Level 1 Energy Converters and with IEEE 115.

B. Project-Specific Equipment Tests: Before shipment, factory test engine-generator set and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:
1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
2. Full load run.
3. Maximum power.
4. Voltage regulation.
5. Transient and steady-state governing.
6. Single-step load pickup.
7. Safety shutdown.
8. Provide 14 days advance notice of tests and opportunity for observation of tests by Owner's representative.
9. Report factory test results within 10 days of completion of test.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine-generator performance.

B. Examine roughing-in of piping systems and electrical connections. Verify actual locations of connections before packaged engine-generator installation.

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

3.2 INSTALLATION

A. Comply with packaged engine-generator manufacturer's written installation and alignment instructions and with NFPA 110.

B. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.

C. Install packaged engine generator with elastomeric isolator pads having a minimum deflection of 1 inch on 4-inch-high concrete base. Secure sets to anchor bolts installed in concrete bases. Concrete base construction is specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

D. Install generator exhaust through roof of building as indicated on the drawings.

E. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

3.3 STARTUP AND COMMISSIONING

A. The supplier of the electric generator and associated items covered herein shall provide factory trained technicians to validate the completed installation and to perform an initial startup inspection to include:

B. Ensuring the engine starts (both hot and cold) within the specified time.

C. Verification of engine parameters within specification.

D. Verify no load frequency and voltage, adjusting if required.

E. Test all automatic shutdowns of the engine-generator.

3.4 TRAINING

A. Training is to be supplied by the start-up technician for the end-user during commissioning. The training should cover basic generator operation and common generator issues that can be managed by the end-user.

B. Training is to include manual operation of system.

3.5 CONNECTIONS

A. Drawings indicate general arrangement of piping and specialties.

B. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance.

C. Connect cooling-system water piping to engine-generator set and heat exchanger with flexible connectors.

D. Connect engine exhaust pipe to engine with flexible connector.

E. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems," and as indicated on the drawings.

F. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.6 IDENTIFICATION

A. Identify system components according to Section 260553 "Identification for Electrical Systems."

3.7 FIELD QUALITY CONTROL

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

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing. Contractor shall be responsible to provide fuel, the load banks and other related components to perform the tests. Submit a written test procedures for A/E and owner's approval.

C. Perform tests and inspections and prepare test reports.
1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Tests and Inspections:
1. Perform tests recommended by manufacturer and each electrical test and visual and mechanical inspection (except those indicated to be optional) for "AC Generators and for Emergency Systems" specified in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, single-step full-load pickup test. The tests shall run for minimum of 4 hours. Step loading to 25% 50% 7% and 100% loading shall be performed. A block load shedding to 50% shall be used to demonstrate stability of the system.
3. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.
   a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.

b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
c. Verify acceptance of charge for each element of the battery after discharge.
d. Verify that measurements are within manufacturer's specifications.

4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
5. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.
6. Exhaust-System Back-Pressure Test: Use a manometer with a scale exceeding 40-inch wg. Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the engine.
7. Exhaust Emissions Test: Comply with applicable government test criteria.
8. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.
9. Harmonic-Content Tests: Measure harmonic content of output voltage under 25 percent and at 100 percent of rated linear load. Verify that harmonic content is within specified limits.
10. Noise Level Tests: Measure A-weighted level of noise emanating from generator-set installation, including engine exhaust and cooling-air intake and discharge, at four locations on the property line, and compare measured levels with required values.

E. Coordinate tests with tests for transfer switches and run them concurrently.

F. Test instruments shall have been calibrated within the last 12 months, traceable to standards of NIST, and adequate for making positive observation of test results. Make calibration records available for examination on request.

G. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

H. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

I. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

J. Remove and replace malfunctioning units and retest as specified above.

K. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

L. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

3.8 DEMONSTRATION

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

END OF SECTION 263213

SECTION 263600 - AUTOMATIC TRANSFER SWITCHES

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.

B. Related Sections include the following:
1. Section 263213 "Engine Generators"

1.2 DESCRIPTION OF WORK

A. Furnish and install automatic transfer switches (ATS) with number of poles, amperage, voltage, withstand and close-on ratings as shown on the plans. Each automatic transfer switch shall consist of an inherently double throw power transfer switch mechanism and a microprocessor controller to provide automatic operation.

B. This Section includes transfer switches rated 600 V and less, including the following:
1. Automatic transfer switches.

1.3 ACTION SUBMITTALS

A. Power Systems Studies specified in Section 260573, shall be completed and submitted prior to submitting shop drawings for this section.

B. Product Data: For each type of product indicated. Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.

C. Shop Drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.
1. Single-Line Diagram: Show connections between transfer switch, power sources, and load.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer.

B. Field quality-control test reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals. In addition to items specified in "Operation and Maintenance Data," include the following:
   1. Features and operating sequences, both automatic and manual.
   2. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Maintain a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than eight hours from time of notification.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
   1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

C. Source Limitations: Transfer switches and controllers, other than equipment specified and furnished with the fire pump, shall be the products of the same manufacturer.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with NEMA ICS 1.

F. Comply with NFPA 70.

G. Comply with NFPA 110.

H. Comply with UL 1008 unless requirements of these Specifications are stricter.

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 Section 033000 "Cast-in-Place Concrete."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Caterpillar; Engine Div.
   b. Generac Power Systems, Inc.
   c. Schneider Electric; ASCO Power Technologies, LP.
   d. GE Zenith Controls.
   e. Kohler Power Systems; Generator Division.
   f. Onan/Cummins Power Generation; Industrial Business Group.
   g. Russelectric, Inc.
   h. Spectrum Detroit Diesel.
   i. Approved Equal.

2.2 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

A. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.

B. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.
   a. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.

C. Solid-State Controls: Repetitive accuracy of all settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.

D. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

E. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.

F. Switch Characteristics: Designed for continuous-duty, repetitive transfer of full-rated current between active power sources.
   a. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are not acceptable.
   b. Switch Action: Double throw; mechanically held in both directions.
   c. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 225 A and higher, shall have separate arcing contacts.

G. Neutral Switching. Where four-pole switches are indicated, provide neutral pole switched simultaneously with phase poles.

H. Neutral Terminal: Solid and fully rated, unless otherwise indicated.

I. Battery Charger: For generator starting batteries.
1. Float type; manufacturer's standard rating.
2. Ammeter to display charging current.
3. Fused ac inputs and dc outputs.

J. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device.

K. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, either by color-code or by numbered or lettered wire and cable tape markers at terminations. Color-coding and wire and cable tape markers are specified in Section 260553 "Identification for Electrical Systems."
1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.

L. Enclosures: Provide enclosures listed for use in the environment present where shown on the drawings, unless otherwise indicated.

2.3 AUTOMATIC TRANSFER SWITCHES

A. Comply with Level 1 equipment according to NFPA 110.

B. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.

C. Manual Switch Operation: Unloaded. Control circuit automatically disconnects from electrical operator during manual operation.

D. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval is adjustable from 1 to 30 seconds.

E. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.

F. Automatic Transfer-Switch Features:
1. Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
2. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.

3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
4. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes to automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
5. Test Switch: Simulate normal-source failure.
6. Switch-Position Pilot Lights: Indicate source to which load is connected.
7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.
    a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
    b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."
8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
9. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
10. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
11. Engine Shutdown Contacts: Instantaneous; shall initiate shutdown sequence at remote engine-generator controls after retransfer of load to normal source.
12. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
13. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory settings are for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:
    a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
    b. Push-button programming control with digital display of settings.
    c. Integral battery operation of time switch when normal control power is not available.

2.4 REMOTE ANNUNCIATOR SYSTEM

A. Functional Description: Remote annunciator panel shall annunciate conditions for indicated transfer switches. Annunciation shall include the following:
    1. Sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
    2. Switch position.
    3. Switch in test mode.
    4. Failure of communication link.

B. Annunciator Panel: LED-lamp type with audible signal and silencing switch.

1. Indicating Lights: Grouped for each transfer switch monitored.
2. Label each group, indicating transfer switch it monitors, location of switch, and identity of load it serves.
3. Mounting: Flush, modular, steel cabinet, unless otherwise indicated.
4. Lamp Test: Push-to-test or lamp-test switch on front panel.

2.5 REMOTE ANNUNCIATOR AND CONTROL SYSTEM

A. Functional Description: Include the following functions for indicated transfer switches:
1. Indication of sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
2. Indication of switch position.
3. Indication of switch in test mode.
4. Indication of failure of digital communication link.
5. Key-switch or user-code access to control functions of panel.
6. Control of switch-test initiation.
7. Control of switch operation in either direction.
8. Control of time-delay bypass for transfer to normal source.

B. Malfunction of annunciator, annunciation and control panel, or communication link shall not affect functions of automatic transfer switch. In the event of failure of communication link, automatic transfer switch automatically reverts to stand-alone, self-contained operation. Automatic transfer-switch sensing, controlling, or operating function shall not depend on remote panel for proper operation.

C. Remote Annunciation and Control Panel: Solid-state components. Include the following features:
1. Controls and indicating lights grouped together for each transfer switch.
2. Label each indicating light control group. Indicate transfer switch it controls, location of switch, and load it serves.
3. Digital Communication Capability: Matched to that of transfer switches supervised.
4. Mounting: Flush, modular, steel cabinet, unless otherwise indicated.

2.6 SOURCE QUALITY CONTROL

A. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Design each fastener and support to carry load indicated by seismic requirements and according to seismic-restraint details.

B. Floor-Mounting Switch: Anchor to floor by bolting.

1. Concrete Bases: 4 inches (100 mm) high, reinforced, with chamfered edges. Extend base no more than 4 inches (100 mm) in all directions beyond the maximum dimensions of switch, unless otherwise indicated or unless required for seismic support. Construct concrete bases according to Section 260529 "Hangers and Supports for Electrical Systems."

C. Annunciator and Control Panel Mounting: Flush in wall, unless otherwise indicated.

D. Identify components according to Section 260553 "Identification for Electrical Systems."

E. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

3.2 CONNECTIONS

A. Wiring to Remote Components: Match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Testing Agency: [Owner will engage] [Engage] a qualified independent testing and inspecting agency to perform tests and inspections and prepare test reports.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

C. Perform tests and inspections and prepare test reports.
1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installation, including connections, and to assist in testing.
2. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
4. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.
    a. Check for electrical continuity of circuits and for short circuits.
    b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
    c. Verify that manual transfer warnings are properly placed.
    d. Perform manual transfer operation.

5. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.
    a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
    b. Simulate loss of phase-to-ground voltage for each phase of normal source.
    c. Verify time-delay settings.
    d. Verify pickup and dropout voltages by data readout or inspection of control settings.
    e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
    f. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for 1 pole deviating by more than 50 percent from other poles.
    g. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and
6. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.
    a. Verify grounding connections and locations and ratings of sensors.

D. Testing Agency's Tests and Inspections:
1. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
3. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.
    a. Check for electrical continuity of circuits and for short circuits.
    b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
    c. Verify that manual transfer warnings are properly placed.
    d. Perform manual transfer operation.
4. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.
    a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
    b. Simulate loss of phase-to-ground voltage for each phase of normal source.
    c. Verify time-delay settings.
    d. Verify pickup and dropout voltages by data readout or inspection of control settings.
    e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
    f. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for 1 pole deviating by more than 50 percent from other poles.
    g. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.
5. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.

a. Verify grounding connections and locations and ratings of sensors.

E. Coordinate tests with tests of generator and run them concurrently.

F. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

G. Remove and replace malfunctioning units and retest as specified above.

H. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.
1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.
2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
3. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below. Refer to Section 017900 "Demonstration and Training."

B. Coordinate this training with that for generator equipment.

END OF SECTION 263600

SECTION 264313 - SURGE PROTECTIVE DEVICES (SPDs) FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - GENERAL

1.1 SCOPE

A. This section describes the materials and installation requirements for surge protective devices (SPD) for the protection of all AC electrical circuits.

1.2 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. Other sections that may relate to the work in this section include, but are not limited to, the following:
1. Section 26 24 16 – Panelboards

1.3 SUBMITTALS

A. Submit shop drawings and product information for approval and final documentation in the quantities listed according to the Conditions of the Contract. All transmittals shall be identified by customer name, customer location, and customer order number.

B. Submittals shall include UL 1449 4th Edition Listing documentation verifiable by visiting www.UL.com, clicking "Certifications" link, searching using UL Category Code: VZCA and VZCA2:
1. Short Circuit Current Rating (SCCR)
2. Voltage Protection Ratings (VPRs) for all modes
3. Maximum Continuous Operating Voltage rating (MCOV)
4. I-nominal rating (I-n)
5. SPD shall be UL listed and labeled as Type 1 or Type 4 intended for Type 1 or Type 2 applications.

C. Upon request, an unencapsulated but complete SPD formally known as TVSS shall be presented for visual inspection.

D. Minimum of ten (10) year warranty.

E. Product Certificates: For SPD devices, from manufacturer.

F. Field quality-control reports.

G. Warranties: Sample of special warranties.

1.4 RELATED STANDARDS

A. IEEE C62.41.1, IEEE Guide on the Surge Environment in Low-Voltage (1000 V and Less) AC Power Circuits,

B. IEEE C62.41.2, IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits,

C. IEEE C62.45, IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and Less) AC Power Circuits.

D. National Electrical Code: Article 285, 700, and 708

E. UL 1283 - Electromagnetic Interference Filters

F. UL 1449, Fourth Edition, Surge Protective Devices

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Engage a firm with at least 5 years experience in manufacturing transient voltage surge suppressors.

B. Manufacturer shall be ISO 9001 or 9002 certified.

C. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of ten (10) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

D. The SPD shall be compliant with the Restriction of Hazardous Substances (RoHS) Directive 2002/95/EC.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For SPD devices to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Replaceable Protection Modules: One of each size and type installed.

1.8 DELIVERY, STORAGE AND HANDLING

A. Handle and store equipment in accordance with manufacturer's Installation and Maintenance Manuals. One (1) copy of this document to be provided with the equipment at time of shipment.

1.9 PROJECT CONDITIONS

A. Service Conditions: Rate SPD devices for continuous operation under the following conditions unless otherwise indicated:
1. Maximum Continuous Operating Voltage: Not less than 115 percent of nominal system operating voltage.
2. Operating Temperature: 30 to 120 deg F (0 to 50 deg C).
3. Humidity: 0 to 85 percent, noncondensing.
4. Altitude: Less than 20,000 feet (6090 m) above sea level.

1.10 COORDINATION

A. Coordinate location of field-mounted SPD devices to allow adequate clearances for maintenance.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Provide an internally mounted Surge Protective Devices (SPD):
1. Eaton
2. GE
3. Schneider Electric
4. Siemens Industry
5. Other approved manufacturer

2.2 ELECTRICAL DISTRIBUTION EQUIPMENT

A. Service Entrance

SPD shall be UL 1449 labeled as Type 1 or Type 4 intended for Type 1 or Type 2 applications, verifiable at UL.com, without need for external or supplemental overcurrent controls. Every suppression component of every mode, including N-G, shall be protected by internal overcurrent and thermal overtemperature controls. SPDs relying upon external or supplementary installed safety disconnectors do not meet the intent of this specification.

SPD shall be factory installed integral or externally mounted to electrical distribution equipment. Refer to drawings for additional information.
1. SPD shall be UL labeled with 20kA I-nominal (I-n) (verifiable at UL.com) as recommended for UL 96A Lightning Protection Master Labeling and NFPA 780.
2. SPD shall be UL labeled with 200kA Short Circuit Current Rating (SCCR).
3. Standard 7-Mode Protection paths: SPD shall provide surge current paths for all modes of protection: L-N, L-G, L-L, and N-G for Wye systems; L-L, L-G in Delta and impedance grounded Wye systems. (Delete: If "true 10-Mode" protection is selected.)
4. True 10-Mode Protection paths: SPD shall provide "directly connected protection elements" between all possible modes of protection: L-N, L-G, L-L, and N-G for Wye systems; L-L, L-G in Delta and impedance grounded Wye systems. (Deletable note:

10-Mode protection maybe selected for projects where discrete L-L MOV protection is preferred. For most projects this feature is not required.).

5. SPD shall be connected to the buss of the distribution equipment with an appropriately sized 200kA SCCR rated disconnect.
6. SPD shall meet or exceed the following criteria:
   a. Maximum surge current capability shall be [200kA] [300kA] [400kA] [500kA] per phase.
   b. UL 1449 – Fourth Edition Revision; Voltage Protection Ratings shall not exceed the following:

VOLTAGE	L-N	L-G	N-G	L-L	MCOV
208Y/120	700V	700V	700V	1200V	150V

7. UL 1449 Listed Maximum Continuous Operating Voltage (MCOV) (verifiable at UL.com):

System Voltage	Allowable System Voltage Fluctuation (%)	MCOV
208Y/120	25%	150V

8. SPD shall incorporate a UL 1283 listed EMI/RFI filter with minimum attenuation of -50dB at 100 kHz.
9. Suppression components shall be heavy duty 'large block' MOVs, each exceeding 30mm diameter.
10. SPD shall include a serviceable, replaceable module.
11. Integral disconnect switch.
12. SPD shall be equipped with the following diagnostics:
    a. Visual LED diagnostics including a minimum of one green LED indicator per phase, and one red service LED.
    b. Audible alarm with on/off silence function and diagnostic test function (excluding branch).
    c. Form C dry contacts
    d. Optional – Surge Counter

    No other test equipment shall be required for SPD monitoring or testing before or after installation.
13. SPD shall have a response time no greater than 1/2 nanosecond.
14. SPD shall have a 10 year warranty.

B. Branch Panels with integral SPD
   1. Provide panelboards by the same manufacturer used for panelboards specified in 262416.
   2. The panelboard shall be UL 67 Listed and the SPD shall be UL 1449 labeled as Type 1 or as Type 4 intended for Type 1 or Type 2 applications.
   3. The unit shall be top or bottom feed according to requirements. A circuit directory shall be located inside the door.
   4. SPD shall meet or exceed the following criteria:
      a. Maximum surge current capability shall be [100kA] or [200kA] per phase.
      b. UL 1449 – Fourth Edition Revision; Voltage Protection Ratings shall not exceed the following:

VOLTAGE	L-N	L-G	N-G	L-L	MCOV
208Y/120	700V	700V	700V	1200V	150V

5. UL 1449 Listed Maximum Continuous Operating Voltage (MCOV) (verifiable at UL.com):

System Voltage	Allowable System Voltage Fluctuation (%)	MCOV
208Y/120	25%	150V

6. SPD shall incorporate a UL 1283 listed EMI/RFI filter with minimum attenuation of -50dB at 100 kHz.
7. Suppression components shall be heavy duty 'large block' MOVs, each exceeding 30mm diameter.
8. SPD shall include a serviceable, replaceable module.
9. SPD shall be equipped with the following diagnostics:
   a. Visual LED diagnostics including a minimum of one green LED indicator per phase, and one red service LED.
   b. Audible alarm with on/off silence function and diagnostic test function (excluding branch).
   c. Form C dry contacts
   d. Optional – Surge Counter

   No other test equipment shall be required for SPD monitoring or testing before or after installation.
10. SPD shall have a response time no greater than 1/2 nanosecond.
11. SPD shall have a 10 year warranty.
12. The unit shall have removable interior.
13. The main bus shall be [copper] [aluminum] and rated for the load current required.
14. The unit shall include a 200% rated neutral assembly with copper neutral bus.
15. The unit shall be provided with a safety ground bus.
16. The field connections to the panelboard shall be main lug or main breaker.
17. The unit shall be constructed with flush or surface mounted trim and shall be in a NEMA Type 1 enclosure.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install SPD devices at service entrance on load side, with ground lead bonded to service entrance ground.

B. Install SPD devices for panelboards and auxiliary panels with conductors or buses between suppressor and points of attachment as short and straight as possible. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.
   1. Provide, multi-pole circuit breaker as a dedicated disconnecting means for SPD unless otherwise indicated.

3.2 STARTUP SERVICE

A. Do not energize or connect service entrance equipment or panelboards to their sources until SPD devices are installed and connected.

B. Do not perform insulation resistance tests of the distribution wiring equipment with the SPD installed. Disconnect before conducting insulation resistance tests, and reconnect immediately after the testing is over.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect equipment installation, including connections and to assist in field testing. Report results in writing.
1. Verify that electrical wiring installation complies with manufacturer's written installation requirements.

B. Testing: Perform the following field tests and inspections and prepare test reports:
1. After installing surge protection devices, but before electrical circuitry has been energized, test for compliance with requirements.
2. Complete startup checks according to manufacturer's written instructions.
3. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, "Surge Arresters, Low-Voltage Surge Protection Devices" Section. Certify compliance with test parameters.

C. Remove and replace malfunctioning units and retest as specified above.

3.4 ADJUSTMENTS AND CLEANING

A. Remove debris from installation site and wipe dust and dirt from all components.

B. Repaint marred and scratched surfaces with touch up paint to match original finish.

3.5 TESTING

A. Check tightness of all accessible mechanical and electrical connections to assure they are torqued to the minimum acceptable manufacture's recommendations.

B. Check all installed panels for proper grounding, fastening and alignment.

3.6 WARRANTY

A. Equipment manufacturer warrants that all goods supplied are free of non-conformities in workmanship and materials for one year from date of initial operation, but not more than eighteen months from date of shipment.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to maintain SPD devices. Refer to Division 01 Section "Project Closeout".

END OF SECTION 264313

SECTION 265100 - INTERIOR SOLID-STATE LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Related Sections:
1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multi-pole lighting relays and contactors.

1.2 DESCRIPTION OF WORK

A. Section Includes:
1. Interior lighting fixtures, lamps, and drivers.
2. Emergency lighting units.
3. Exit signs.
4. Lighting fixture supports.

1.3 REFERENCES

A. ANSI/NFPA 70, National Electrical Code

B. IESNA LM-79, Electrical and Photometric Measurements of Solid-State Lighting Products

C. IESNA LM-80, Approved Method for Measuring Lumen Maintenance of LED Light Sources

D. IESNA TM-21, Luminaire Classification System for Indoor Luminaires

E. UL1598, Standard for Safety of Luminaires

1.4 ACTION SUBMITTALS

A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, and finishes.

B. Shop Drawings: Show details of nonstandard or custom lighting fixtures. Indicate dimensions, weights, methods of field assembly, components, features, and accessories. Product Certificates: For each type of ballast for bi-level and dimmer-controlled fixtures, from manufacturer.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

C. Luminaires shall be fully assembled and individually electrically tested prior to shipment.

D. Manufacturers of LED luminaires shall demonstrate a suitable testing program to ensure system reliability and to substantiate lifetime claims.

E. The sole use of IESNA LM-80 data to predict luminaire lifetime is not acceptable.

F. At time of manufacture, electrical and light technical properties shall be recorded for each luminaire. At a minimum, this should include lumen output, CCT, and CRI. Each luminaire shall utilize a unique serial numbering scheme. Technical properties must be made available for a minimum of 5 years after the date of manufacture.

G. Luminaires shall be provided with a minimum 5 year warranty covering, LEDs, drivers and paint finish.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, product(s) indicated on Drawings.

B. Provide fixtures as indicated on the fixture schedules, or as allowed by Architect/Engineer if of alternate manufacturer. For alternate manufacturer, provide complete lighting photometrics on AutoCAD floor plans as part of the required lighting submittals for review by Architect/Engineer.

C. Contractor shall coordinate light fixture finishes with Architect.

2.2 GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS

A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.

B. Metal Parts: Free of burrs and sharp corners and edges.

C. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.

D. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit re-lamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

E. Diffusers and Globes:
1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
   a. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.
   b. UV stabilized.
2. Glass: Annealed crystal glass unless otherwise indicated.

2.3 DRIVERS FOR LED FIXTURES

A. Electronic Driver for LED Fixtures: Comply with UL 1310 Class 2 requirements for dry and damp locations. Include the following features unless otherwise indicated:
1. Rated for 50,000 hours of life, unless otherwise noted.
2. Sound Rating: Class A.
3. Total Harmonic Distortion Rating: 15 percent or less.
4. Current Crest Factor: 1.5 or less.
5. 0-10V Dimming Standard (Step Dimming does not qualify)

2.4 EXIT SIGNS

A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:
1. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.
2. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
   a. Battery: Sealed, maintenance-free, nickel-cadmium type.
   b. Charger: Fully automatic, solid-state type with sealed transfer relay.
   c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
   d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
   e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

2.5 EMERGENCY LIGHTING UNITS

A. General Requirements for Emergency Lighting Units: Self-contained units complying with UL 924.
1. Battery: Sealed, maintenance-free, lead-acid type.
2. Charger: Fully automatic, solid-state type with sealed transfer relay.
3. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
5. If unit is provided with separately mounted / field mounted Test Push Button, Contractor shall provide separately mounted box for pushbutton, including interconnecting wiring.
6. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
7. Wire Guard: Heavy-chrome-plated wire guard protects lamp heads or fixtures.
8. Integral Time-Delay Relay: Holds unit on for fixed interval of [15] <Insert period> minutes when power is restored after an outage.

2.6 LED FIXTURES

A. Except as otherwise indicated, provide LED luminaires, of types and sizes indicated on fixture schedules.

B. Include the following features unless otherwise indicated:
1. Each Luminaire shall consist of an assembly that utilizes LEDs as the light source. In addition, a complete luminaire shall consist of a housing, LED array, and electronic driver (power supply).
2. Each luminaire shall be rated for a minimum operational life of 50,000 hours utilizing a minimum ambient temperature of (25°C).
3. Light Emitting Diodes tested under LM-80 Standards for a minimum of 12,000 hours.
4. Color Rendering Index (CRI) of 82 at a minimum.
5. Color temperature [3500] <Insert value> K, unless otherwise indicated.
6. Rated lumen maintenance at 70% lumen output for 50,000 hours, unless otherwise indicated.
7. Fixture efficacy of 60 Lumens/Watt, minimum.
8. 5 year luminaire warranty, minimum.
9. Photometry must comply with IESNA LM-79.
10. The individual LEDs shall be constructed such that a catastrophic loss of the failure of one LED will not result in the loss of the entire luminaire.
11. Luminaire shall be constructed such that LED modules may be replaced or repaired without the replacement of the whole fixture.

C. Technical Requirements
1. Luminaire shall have a minimum efficacy of 60 lumens per watt. The luminaire shall not consume power in the off state.
2. Operation Voltage: The luminaire shall operate from a 50 HZ to 60 HZ AC line over a voltage ranging from 120 VAC to 277 VAC. The fluctuations of line voltage shall have no visible effect on the luminous output.
3. Power Factor: The luminaire shall have a power factor of 0.9 or greater.
4. THD: Total harmonic distortion (current and voltage) induced into an AC power line by a luminaire shall not exceed 15 percent.
5. Operational Performance: The LED circuitry shall prevent visible flicker to the unaided eye over the voltage range specified above.

D. Thermal Management
1. The thermal management (of the heat generated by the LEDs) shall be of sufficient capacity to assure proper operation of the luminaire over the expected useful life.
2. The LED manufacturer's maximum thermal pad temperature for the expected life shall not be exceeded.
3. Thermal management shall be passive by design. The use of fans or other mechanical devices shall not be allowed.
4. The luminaire shall have a minimum heat sink surface such that LED manufacturer's maximum junction temperature is not exceeded at maximum rated ambient temperature.

2.7 LIGHTING FIXTURE SUPPORT COMPONENTS

A. Comply with Section 260529 "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.

C. Twin-Stem Hangers: Two, 1/2-inch (13-mm) steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.

D. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.

E. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Lighting fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.

B. Comply with NFPA 70 for minimum fixture support.

C. Suspended Lighting Fixture Support:
1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.

D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.2 FIELD QUALITY CONTROL

A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

B. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION 265100

SECTION 265600 - EXTERIOR SOLID-STATE LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Related Sections:

Section 26 51 00 "Interior Solid State Lighting" for exterior luminaires normally mounted on exterior surfaces of buildings.

1.2 DESCRIPTION OF WORK

A. Section Includes:
1. Exterior luminaires with lamps, ballasts and drivers.
2. Luminaire-mounted photoelectric relays.
3. Poles and accessories.

1.3 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color-rendering index.

C. HID: High-intensity discharge.

D. LED: Light Emitting Diode.

E. LER: Luminaire efficacy rating.

F. Luminaire: Complete lighting fixture, including ballast housing if provided.

G. Pole: Luminaire support structure, including tower used for large area illumination.

H. Standard: Same definition as "Pole" above.

1.4 REFERENCES

A. ANSI/NFPA 70, National Electrical Code

B. IEEE C62.41, Guide on the Surge Environment in Low-Voltage (1000 V and Less) AC Power Circuits

C. FCC 47 CFR Part 15, Federal Code Of Regulation (CFR) testing standard for electronic equipment

D. IESNA LM-79, Electrical and Photometric Measurements of Solid-State Lighting Products

E. IESNA LM-80, Approved Method for Measuring Lumen Maintenance of LED Light Sources

F. IESNA TM-15, Luminaire Classification System for Outdoor Luminaires

G. IESNA TM-21-11, Projecting Long Term Lumen Maintenance of LED Light Sources

H. UL1598, Standard for Safety of Luminaires

I. NEMA SSL 3-2010, High-Power White LED Binning for General Illumination

1.5 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

A. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-4-M.

B. Live Load: Single load of 500 lbf, distributed as stated in AASHTO LTS-4-M.

C. Ice Load: Load of 3 lbf/sq. ft., applied as stated in AASHTO LTS-4-M Ice Load Map.

D. Wind Load: Pressure of wind on pole and luminaire and banners and banner arms, calculated and applied as stated in AASHTO LTS-4-M.
1. Basic wind speed for calculating wind load for poles 50 feet high or less is 90 mph.
   a. Wind Importance Factor: 1.0
   b. Minimum Design Life: 25 years
   c. Velocity Conversion Factors: 1.0

1.6 ACTION SUBMITTALS

A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:
1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.
2. Details of attaching luminaires and accessories.
3. Details of installation and construction.
4. Luminaire materials.
5. Photometric data based on laboratory tests of each luminaire type, complete with indicated lamps, ballasts, and accessories.
   a. Testing Agency Certified Data: For indicated luminaires, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
   b. Manufacturer Certified Data: Photometric data shall be certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
6. Photoelectric relays.
7. Lamps, including life, output, CCT, CRI, lumens, and energy-efficiency data.
8. Materials, dimensions, and finishes of poles.
9. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.
10. Anchor bolts for poles.
11. Manufactured pole foundations.

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. Anchor-bolt templates keyed to specific poles and certified by manufacturer.
3. Design calculations, certified by a qualified professional engineer, indicating strength of screw foundations and soil conditions on which they are based.
4. Wiring Diagrams: For power, signal, and control wiring.

C. Lighting Photometrics: Provide complete lighting photometrics on AutoCAD format site plans indicating light levels throughout. Provide photometrics for all lighting levels indicated on the drawings, such as dimming / reduced power mode.

1.7 INFORMATIONAL SUBMITTALS

A. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements in AASHTO LTS-4-M and that load imposed by luminaire and attachments has been included in design. The certification shall be based on design calculations by a professional engineer.

B. Qualification Data: For qualified agencies providing photometric data for lighting fixtures.

C. Field quality-control reports.

D. Warranty: Sample of special warranty.

1.8 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and poles, operation, and maintenance manuals.

1.9 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. Optical cartridge system assembly: One for every 20 of each type of [pole mounted] light fixture. Furnish at least one of each [pole mounted] fixture type. Assembly shall include all electrical parts necessary for operation (driver, LED engine, LED lamps, SPD, wiring, etc). If the assembly, as described is not available for the provided fixture type(s), then a complete fixture replacement shall be provided to fulfill this requirement.
2. Surge protective Device Module: One for every 20 of each type of pole mounted light fixture. Furnish at least one of each type.

1.10 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Comply with IEEE C2, "National Electrical Safety Code."

E. Comply with NFPA 70.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Package aluminum poles for shipping according to ASTM B 660.

B. Store poles on decay-resistant-treated skids at least 12 inches above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.

C. Retain factory-applied pole wrappings on fiberglass and laminated wood poles until right before pole installation. Handle poles with web fabric straps.

D. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

1.12 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.
1. Warranty Period for Luminaires: Five years from date of Substantial Completion.
2. Warranty Period for Metal Corrosion: Five years from date of Substantial Completion.
3. Warranty Period for Color Retention: Five years from date of Substantial Completion.
4. Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less than three years from date of Substantial Completion.

B. Contractor Support Warranty: Contractor shall provide field replacement of failed fixtures. This includes all costs for labor, equipment, and miscellaneous items necessary to restore operation of the equipment. This warranty requirement shall be provided within the terms of this Contract regardless of the mode or cause of fixture failure.

1. The Contractor is responsible to provide support and coordination for determining cause of failure and report findings to the Owner, [Architect], and Engineer of Record.

2. If fixture failure or nonoperation is caused by mis-installation, the Contractor shall provide remedial work to bring the installation into compliance with manufacturer's installation and Contractual requirements.

3. If fixtures have failed and subsequently warranted by the manufacturer, then the Contractor shall install replacement equipment provided by the manufacturer.

4. If fixtures have failed and are not warranted by the manufacturer for any reason other than mis-installation, then maintenance materials specified hereinabove shall be used as replacement equipment as necessary.

5. Warranty Period for Contractor Support: One year from date of Substantial Completion or through duration of the manufacturer's warranty, whichever is longer.

6. Timeliness: Contractor shall provide warranty support in a timely manner and provide the Owner with scheduled dates for remedial action necessary to restore operation.

PART 2 PRODUCTS

2.1 LED LUMINAIRES

A. General: Except as otherwise indicated, provide LED luminaires, of types and sizes indicated on fixture schedules.

B. Provide fixtures as indicated on the fixture schedules, or as allowed by Architect/Engineer if of alternate manufacturer. For alternate manufacturer, provide complete lighting photometrics on AutoCAD site plan as part of the required lighting submittals for review by Architect/Engineer.

C. Contractor shall coordinate light fixture & pole finishes with Architect.

D. Material and specifications for each luminaire are as follows:
   1. Each Luminaire shall consist of an assembly that utilizes LEDs as the light source. In addition, a complete luminaire shall consist of a housing, LED array, and electronic driver (power supply).
   2. Each luminaire shall be listed with Underwriters Laboratory, Inc. under UL1598 (wet location) for luminaires, or an approved equivalent standard from a nationally recognized testing laboratory.
   3. NRTL Compliance: Luminaires shall be listed and labeled for indicated class and division of hazard by an NRTL.
   4. L70 lamp life of 50,000 hours.
   5. The rated operating temperature range shall be -40°C (-40°F) to +40°C (104°F).
   6. Each luminaire is capable of operating above 104°F (40°C), but not expected to comply with photometric requirements at elevated temperatures.
   7. Photometry must be compliant with IESNA LM-79 and shall be conducted at 25°C ambient temperature.
   8. Each luminaire shall meet all parameters of this specification throughout the minimum operational life when operated at the average nighttime temperature.
   9. The individual LEDs shall be constructed such that a catastrophic loss or the failure of one LED will not result in the loss of the entire luminaire.
   10. Luminare shall be constructed such that LED modules may be replaced or repaired without replacement of whole luminaire.
   11. Source Limitations: For luminaires, obtain each luminaire type designation from single source with resources to provide products of consistent quality in appearance and physical properties.

E. Technical Requirements
   1. Electrical
      a. Luminaire shall have a minimum efficacy of the scheduled fixture (basis of design). The luminaire shall not consume power in the off state.
      b. Operation Voltage: The luminaire shall operate from a 60 HZ ±3 HZ AC line over a voltage ranging from 108 VAC to 305 VAC. The fluctuations of line voltage shall have no visible effect on the luminous output.
      c. Power Factor: The luminaire shall have a power factor of 0.90 or greater.
      d. THD: Total harmonic distortion (current and voltage) induced into an AC power line by a luminaire shall not exceed 20 percent.
      e. Surge Suppression: The luminaire on-board circuitry shall include surge protection device (SPD) to withstand high repetition noise transients as a result of utility line switching, nearby lightning strikes, and other interference. The SPD protects the luminaire from damage and failure for common and differential mode transient peak currents up to [20kA] [10 kA] (minimum). SPD conforms to UL 1449.

SPD performance has been tested per procedures in ANSI/IEEE C62.41-2:2002 category C high exposure and ANSI C136.2 10kV BIL. The SPD shall fail in such a way as the Luminaire will no longer operate. The SPD shall be field replaceable.

f. Operational Performance: The LED circuitry shall prevent visible flicker to the unaided eye over the voltage range specified above.
g. RF Interference: LED Drivers must meet Class A emission limits referred in Federal Communications Commission (FCC) Title 47, Subpart B, Section 15 regulations concerning the emission of electronic noise.
h. Drivers shall be an IP66 rated UL class 2 power unit as per UL 1310 with a Class A sound rating and comply with FCC rules and regulations as per Title 47 CFR part 15.

2. Photometric Requirements
   a. Optical Assemblies: Illumination shall be provided through a single injection molded acrylic lens with microscopic inclusions that form a repeatable and redundant pattern to direct light in a precisely prescribed type 5 distribution patterns. Individual LEDs shall not be visible. Optical assemblies shall have a minimum efficiency of 85% regardless of distribution type. The optical assembly shall be designed such that catastrophic failures of individual LEDs will not constitute a loss in the distribution pattern.
   b. Light Color/Quality: Unless otherwise indicated on the lighting fixture schedule on the drawings, the luminaire shall have a correlated color temperature (CCT) of 4,000K +/-275K. The color rendition index (CRI) shall be 70 minimum.
   c. The optical assembly of the luminaire shall be protected against dust and moisture intrusion per the requirements of IP-66 (minimum) to protect all optical components.
3. Thermal Management
   a. The thermal management (of the heat generated by the LEDs) shall be of sufficient capacity to assure proper operation of the luminaire over the expected useful life.
   b. The LED manufacturer's maximum thermal pad temperature for the expected life shall not be exceeded.
   c. Thermal management shall be passive by design. The use of fans or other mechanical devices shall not be allowed.
   d. The luminaire shall have a minimum heat sink surface such that LED manufacturer's maximum junction temperature is not exceeded at maximum rated ambient temperature.
   e. The heat sink material shall be aluminum.
4. Physical and Mechanical Requirements
   a. The luminaire shall be a single, self-contained device, not requiring on-site assembly for installation. The power supply for the luminaire shall be integral to the unit.
   b. The maximum weight of the luminaire shall be 16 lbs.
   c. The housing shall meet the requirements for NEMA/UL wet location, be UL listed, IP66 rated.
   d. Each housing shall be provided with a universal, galvanized steel quick mount plate with click-and-lock tab releases that will mate with standard one-gang, two-gang or 4" round wet location junction box. Mounting mechanism shall provide a provision for retaining fixture during wiring. Mounting shall allow wire inspection without disassembling luminaire or entering electrical chamber. Luminaire options shall include 0-10V dimming driver, occupancy sensor, integral cold weather battery pack, and 50°C high ambient operation.
   e. The assembly and manufacturing process for the LED luminaire shall be designed to assure all internal components are adequately supported to

withstand mechanical shock and vibration. Luminaire vibration rating shall be 3G minimum.

f. The electronics/power supply enclosure shall meet the requirements for NEMA/UL wet location.

5. Materials
   a. Housing and door frame shall be aluminum with a nominal 2.5 mil thick paint finish able to withstand a 3000-hour salt spray test as specified in ASTM Designation: B117.
   b. Each refractor or lens shall be made from UV inhibited high impact optical grade acrylic and be resistant to scratching.

2.2 GENERAL REQUIREMENTS FOR POLES AND SUPPORT COMPONENTS

A. Structural Characteristics: Comply with AASHTO LTS-4-M.
   1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in "Structural Analysis Criteria for Pole Selection" Article.
   2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.

B. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.

C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.
   1. Materials: Shall not cause galvanic action at contact points.
   2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.
   3. Anchor-Bolt Template: Plywood or steel.

D. Handhole: Oval-shaped, with minimum clear opening of 2-1/2 by 5 inches, with cover secured by stainless-steel captive screws. Provide on all, except wood poles.

E. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete."

F. Breakaway Supports: Frangible breakaway supports, tested by an independent testing agency acceptable to authorities having jurisdiction, according to AASHTO LTS-4-M.

2.3 ALUMINUM POLES

A. Poles: Seamless, extruded structural tube complying with ASTM B 429/B 429M, Alloy 6063-T6 with access handhole in pole wall.

B. Poles: ASTM B 209, 5052-H34 marine sheet alloy with access handhole in pole wall.
   1. Shape: Refer to Light Fixture Schedule
   2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

C. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

D. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Section 260526 "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

E. Brackets for Luminaires: Detachable, with pole and adapter fittings of cast aluminum. Adapter fitting welded to pole and bracket, then bolted together with stainless-steel bolts.

1. Tapered oval cross section, with straight tubular end section to accommodate luminaire.
2. Finish: Same as luminaire.

F. Prime-Coat Finish: Manufacturer's standard prime-coat finish ready for field painting.

G. Aluminum Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.
3. Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
4. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.
5. Color: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 LUMINAIRE INSTALLATION

A. Install lamps in each luminaire.

B. Fasten luminaire to indicated structural supports.

1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

C. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources, favoring a north orientation.

3.2 POLE INSTALLATION

A. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.

B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise indicated on Drawings:

1. Fire Hydrants and Storm Drainage Piping: 60 inches.

2. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet.
3. Trees: 15 feet from tree trunk.

C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Section 033000 "Cast-in-Place Concrete."

D. Foundation-Mounted Poles: Mount pole with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.
1. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.
2. Grout void between pole base and foundation. Use non-shrink or expanding concrete grout firmly packed to fill space.
3. Install base covers unless otherwise indicated.
4. Use a short piece of 1/2-inch-diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

E. Poles and Pole Foundations Set in Concrete Paved Areas: Install poles with minimum of 6-inch-wide, unpaved gap between the pole or pole foundation and the edge of adjacent concrete slab. Fill unpaved ring with pea gravel to a level 1 inch below top of concrete slab.

F. Raise and set poles using web fabric slings (not chain or cable).

3.3 BOLLARD LUMINAIRE INSTALLATION

A. Align units for optimum directional alignment of light distribution.

B. Install on concrete base with top 4 inches above finished grade or surface at bollard location. Cast conduit into base, and shape base to match shape of bollard base. Finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 033000 "Cast-in-Place Concrete."

3.4 INSTALLATION OF INDIVIDUAL GROUND-MOUNTING LUMINAIRES

A. Install on concrete base with top 4 inches above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 033000 "Cast-in-Place Concrete."

3.5 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel Conduits: Comply with Section 260533 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch-thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.6 GROUNDING

A. Ground metal poles and support structures according to Section 260526 "Grounding and Bonding for Electrical Systems."
1. Install grounding electrode for each pole unless otherwise indicated.

2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

B. Ground nonmetallic poles and support structures according to Section 260526 "Grounding and Bonding for Electrical Systems."
1. Install grounding electrode for each pole.
2. Install grounding conductor and conductor protector.
3. Ground metallic components of pole accessories and foundations.

3.7 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.
1. Verify operation of photoelectric controls.

C. Illumination Tests:
1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IESNA testing guide(s):
a. IESNA LM-5, "Photometric Measurements of Area and Sports Lighting Installations."
b. IESNA LM-50, "Photometric Measurements of Roadway Lighting Installations."
c. IESNA LM-52, "Photometric Measurements of Roadway Sign Installations."
d. IESNA LM-64, "Photometric Measurements of Parking Areas."
e. IESNA LM-72, "Directional Positioning of Photometric Data."

D. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION 265600

SECTION 27 10 00

STRUCTURED CABLING SYSTEM

PART 1 - GENERAL

1.01 This section identifies the requirements, technical design, and specifications for the structured cabling system at the Kendall County EMS Station No. 3, located in Boerne, Texas (“Owner”). The structured cabling system as specified is an Industry-Standard Category 6A structured cabling system and includes backbone cabling, horizontal cabling and equipment room hardware as specified.

1.02 The Contractor shall provide a Manufacturer’s 20-Year Performance Certification for the installed structured cabling system.

1.03 Contractor shall include materials, equipment, and labor necessary to provide a complete and functional structured cabling system regardless of any items not listed or described in this specification or associated drawings.

1.04 Requirements

A. Contractor Experience Requirements

B. Submittal Requirements

C. Acceptable Manufacturers

D. Codes, Standards and Regulations

E. General Requirements

F. System Requirements

G. Testing Requirements

H. Project Closeout Documentation

I. Attachments

1.05 Related Requirements

A. The Drawings, Specifications, General Conditions, Supplementary General Conditions, and other requirements of Division 1 apply to the work specified in Division 27, and shall be complied with in every respect. The Contractor shall examine all of the items which make up the Contract Documents, and shall coordinate them with the work on the project.

B. Contractor Experience Requirements

1. The Contractor shall be a Leviton Premier Partner prior to submitting a bid for the work. **(Or Panduit Equivalent)**

2. The Contractor shall possess all relevant Manufacturer Certifications (i.e. structured cable systems, testing equipment, etc,) for both the company and individual technicians prior to submitting a bid for the work.

3. The Contractor's Project Manager shall be a Registered Communications Distribution Designer (RCDD) and available for all onsite coordination meetings.

4. The Contractor shall have been in business for a minimum of five (5) years.

5. The Contractor shall have a local office with local technicians and an adequate workforce to complete this project within a 75-mile radius of the project site.

6. The Contractor shall have completed a minimum of five (5) projects similar in size and scope to the Owner's installation, where the systems have been in continuous satisfactory operation for at least one (1) year.

C. Subcontractors shall be identified at the time of bid and comply with the requirements and intentions of these specifications, associated drawings, and related contract documents.

1.06 Submittal Requirements

A. Pre-Installation Submittal

1. Contractor shall not order, purchase, or install any equipment until pre-installation submittals have been accepted in writing by the Architect/Engineer.

2. Contractor shall ensure submittals are submitted in a timely manner to ensure all products can be ordered and received on site in order to not cause any delays. If there are any concerns with any products having long lead times, those products shall be clearly identified in writing so the review and approval can be expedited.

3. All submittals shall be submitted in the same sequence as they are listed in the specifications (i.e. product data in the sequence items are listed in the product data section, manufacturer product certifications for company, manufacturer product certifications for installers, etc.). Submittals not in the proper sequence will not be approved.

4. Manufacturer product data sheets for each proposed system component.

   a. For product data sheets containing more than one (1) part number or product, the Contractor shall clearly identify the specific part number or product being submitted. Product data sheets without the part number clearly identified will not be approved.

5. Manufacturer Product Certifications for Company.

6. Manufacturer Product Certifications for Installers.

7. Manufacturer Certifications for testing equipment technicians.

8. Manufacturer Certifications for testing equipment calibration.

9. RCDD Certificate for Contractor's Project Manager.

10. Manufacturer Warranty letter.

11. Documentation indicating that Contractor has been in business for (5) years.

12. Address of Contractor's local office within a 75-mile radius of the project site.

13. Quantity of full time local technicians within a 75-mile radius of the project site.

14. List of five (5) contractor-installed projects of a similar size and scope that have been in operation for at least (1) year. The Contractor shall provide the following information for each project: Project Name, Project Location, Project Start Date, Project Completion Date, Project Start Cost, Project Completion Cost, Brief Description of Project, Client Point of Contact Name and Phone Number.

15. List of completed and ongoing projects with the Owner. The Contractor shall provide the following information for each project: Project Name, Project Location, Project Start Date, Project Completion Date, Project Start Cost, Project Completion Cost, and Brief Description of Project.

16. List of subcontractors performing any work on the project. List shall clearly identify the subcontractor's legal name and address, the scope of work to be performed by the subcontractors and the overall percentage of the project being provided by the subcontractor. If there are no subcontractors performing any work on the project, submit a statement on company letterhead clearly indicating no subcontractors will be performing any work on this project.

PART 2 - PRODUCTS

2.01 General Requirements

A. The following sections specifically list the acceptable equipment types and items for this project.

B. Architect/Engineer will have final determination of acceptability of all proposed equipment and must approve submitted equipment prior to purchase or installation.

C. Proposed equivalent items must be approved in writing by the Architect/Engineer prior to purchase or installation. Proposed equivalent items must meet or exceed these specifications and the specifications of the specified item.

D. In the event a manufacturer's specified product or part number has changed or is no longer available, Contractor shall substitute the appropriate equivalent manufacturer's part number.

E. In the event of a discrepancy between the specifications and the drawings, the greater quantity and/or better quality will be furnished.

F. For listed products with no part number specified, Contractor shall provide a product that meets the performance requirements of these specifications, industry standard practices, and intended application.

G. All wiring, equipment, and installation materials shall be new and of the highest quality.

H. Labels on all cabling, materials, and equipment must indicate a nationally recognized testing laboratory.

I. Original Equipment Manufacturer (OEM) documentation must be provided to the Architect/Engineer which certifies performance characteristics and compliance with ANSI/TIA/EIA 568-C standards.

J. Contractor shall review all products specified and required for this project to determine if there are any lead times for any products that may cause any delay. Contractor shall clearly identify any concerns with lead times in writing to the Architect/Engineer prior to submitting a proposal for this work. If the Contractor does not identify any concerns with products having long lead times, it will be understood there are no long lead time issues and the Contractor will have all products on-site when needed to complete the job as required.

2.02 Acceptable Manufacturers

A. Horizontal Cable **(Or Panduit Equivalent)**

1. Category 6A UTP Plenum

a. Network Access (Blue Sheath)

1) Superior Essex – 10Gain XP Category 6A – Part Number – 6H-272-2B

2) Berk-Tek Equivalent

2. Category 6 UTP Flooded

a. OSP (Black Sheath)

1) Berk-Tek LANmark-6 OSP UTP Part Number – 10139885

B. Copper Cable Termination

1. Category 6 Horizontal Rack Mounted Patch Panels

a. Leviton 1RU 24-Port QuickPort Flat Panel (Empty) – Part Number 49255-H24

b. Leviton 2RU 48-Port QuickPort Flat Panel (Empty) – Part Number 49255-H48

2. Category 6A Modular Jacks

a. Network Access

1) Equipment Room/Telecommunications Room End (Blue)

a) Leviton QuickPort eXtreme 6A CAT 6A Connector – Part Number 6111G-RL6

2) Field End (Blue)

a) Leviton QuickPort eXtreme 6A CAT 6A Connector – Part Number 6111G-RL6

3. Telecommunications Faceplates with Designation Window

a. 2-Port Single Gang Flush (Stainless Steel)

1) Leviton QuickPort Stainless Steel Wallplate with ID Window – Part Number 43080-1L2

b. 4-Port Single Gang Flush (Stainless Steel)

1) Leviton QuickPort Angled Stainless Steel Wallplate with ID Window – Part Number 43081-1L4

c. 8-Port Double Gang Flush (White)

1) Leviton QuickPort Angled Stainless Steel Wallplate with ID Window – Part Number 43081-2L8

d. Wall Phone Faceplate (Stainless Steel)

1) Leviton QuickPort Stainless Steel Phone Wallplate - Part Number 4108W-1SP

4. 1-Port Surface Mount Box (White)

a. Leviton QuickPort Surface Mount Box – Part Number 41089-1WP

5. 2-Port Surface Mount Box (White)

a. Leviton QuickPort Surface Mount Box – Part Number 41089-2WP

6. 4-Port Surface Mount Box (White)

a. Leviton QuickPort Surface Mount Box – Part Number 41089-4WP

7. Blank Insert (White)

a. Leviton QuickPort Blank Insert (pack of 10) – Part Number 41084-0BW

C. Equipment Racks, Cabinets, Cable Management, and Accessories

1. Two-Post Rack - 19” x 84” Open Frame (Black)

a. Chatsworth – Part Number 55053-703

b. Enhanced Vertical Cable Manager, Wide

1) Chatsworth – Part # 13171-700

c. Enhanced Front to Back Horizontal Manager, Wide 1-pair

1) Chatsworth – Part # 13168-701

d. 23” – 19” Rail Adapter Kit

1) Chatsworth – Part # 10587-701

2. Vertical Cable Managers (Black)

a. Chatsworth Double Sided Vertical Cabling Section - Part Number 11729-703

3. Horizontal Cable Managers (Black)

a. Chatsworth Rack Cabling Manager - Part Number 11753-719

4. Vertical Power Strip for 7’ Equipment Rack

a. Chatsworth 24 Outlet (5-20R) Power Strip with Meter and NEMA 5-20P – Part Number 12848-755

D. Cable Runway (Ladder Type)

1. Universal Cable Runway

a. 12-inch Chatsworth - Part Number 10250-712

b. 18-inch Chatsworth - Part Number 10250-718

c. 24-inch Chatsworth - Part Number 10250-724

2. Cable Runway Radius Drop, Cross Member

a. 12-inch Chatsworth - Part Number 12100-712

b. 18-inch Chatsworth - Part Number 12100-718

3. Cable Runway Radius Drop, Stringer

a. Chatsworth - Part Number 12101-711

4. Cable Runway Butt-Splice Kit

a. Chatsworth - Part Number 11301-701

5. Cable Runway Junction-Splice Kit

    a. Chatsworth - Part Number 11302-701

6. Cable Runway Butt-Swivel Splice Kit

    a. Chatsworth - Part Number 10487-701

7. Rack-to-Runway Mounting Kit

    a. 9 to 12-inch runway Chatsworth - Part Number 10595-712

    b. 15 to 18-inch runway Chatsworth - Part Number 10595-718

    c. 20 to 24-inch runway Chatsworth - Part Number 10595-724

8. Cable Runway Elevation Kit for Racks

    a. Chatsworth - Part Number 10506-706

9. Cable Runway Elevation Kit for Cabinets

    a. Chatsworth - Part Number 10506-706

10. Triangular Support Bracket, Aluminum

    a. 6 to 12-inch runway Chatsworth - Part Number 11312-712

    b. 12 to 18-inch runway Chatsworth - Part Number 11421-718

11. Triangular Support Bracket, Steel

    a. 24-inch runway Chatsworth - Part Number 11746-724

12. Wall Angle Support Kit, Cable Runway

    a. 12-inch runway Chatsworth - Part Number 11421-712

    b. 18-inch runway Chatsworth - Part Number 11421-718

    c. 24-inch runway Chatsworth - Part Number 11421-724

13. 90 Degree Runway-Splice Kit

    a. Chatsworth - Part Number 11314-701

14. 45 Degree Runway-Splice Kit

    a. Chatsworth - Part Number 11313-701

15. Foot Kit, Cable Runway

    a. Chatsworth - Part Number 11309-701

16. Vertical Wall Brackets (pair)

    a. Chatsworth - Part Number 10608-701

17. Threaded Ceiling Kit, Cable Runway

    a. Chatsworth - Part Number 11310-001

18. Threaded Rod Cover

    a. Chatsworth - Part Number 11085-001

19. Protective End Caps for Cable Runway

    a. Chatsworth - Part Number 10642-001

20. End Closing Kit, Cable Runway

    a. Chatsworth - Part Number 11700-712

    b. Chatsworth - Part Number 11700-718

    c. Chatsworth - Part Number 11700-724

E. Pathway Cable Support

1. Panduit J-Mod Cable Support System

2. Erico – CADDY CAT LINKS J-Hook Series

3. Erico – Caddy Adjustable Cable Support Series

4. Panduit Plenum Rated Hook & Loop (Black)

5. Erico – Caddy Grid Support – Part Number – ATA41 or ATS41

F. Grounding and Bonding

1. Grounding Bus Bar, 20”

a. Chatsworth - Part Number 40153-020

2. Grounding Bus Bar, 12”

a. Chatsworth - Part Number 13622-012

3. Cable Runway Ground Strap Kit

a. Chatsworth - Part Number 40164-001

4. Compression Lugs

a. Chatsworth - Part Number 40162-XXX

XXX – Determined based on wire size and hole spacing needed

5. Horizontal Rack Ground Bar for Wall Mount Cabinet

a. Chatsworth - Part Number 10610-019

6. #6 AWG Solid Green Insulation Ground Wire

a. Superior Essex - Part Number 12-018-04

7. #3/0 Stranded Green Insulation Ground Wire

8. Cable Sheath Bonding Clamp

G. Labeling

1. Permanent Labels for Fiber Optic Cables

a. Laser/Ink Jet Self Laminating Labels

1) Panduit Part Number Series – S100X******

2. Permanent Labels for Copper Cables

a. Laser/Ink Jet Self Laminating Labels

1) Panduit Part Number Series – S100X******

3. Permanent Labels for Backbone Fiber Optic Cables

a. Self-Laminating Fiber Optic Cable Marker Tags

1) Panduit Part Number – PST-FO

4. Permanent Labels for Innerduct

a. Self-Laminating Fiber Optic Cable Marker Tags

1) Panduit Part Number – PST-FO

To be used for Innerduct with fiber installed.

2) Panduit Part Number – PST-FOBLNK

To be used for empty spare Innerduct

5. Permanent Labels for Patch Panels

a. Panduit Component Label

6. Permanent Labels for Faceplates

a. Panduit Component Label

H. Fire Stop

1. STI Spec Seal Part Number

2. 3M Products Part Number

I. Plywood

1. 8’ H x 4’ W x ¾” Sheets of BC grade fire-rated plywood

J. Fire Retardant Paint (White)

K. Fiber Patch Cables

1. Leviton Fiber Optic Patch Cords

L. Copper Patch Cables **(Or Panduit Equivalent)**

1. Data - Leviton SlimLine 10gig UTP Patch Cord – Part Number – 6210G-xxL - (Blue)

2. Audio / Visual - Leviton SlimLine 10gig UTP Patch Cord – Part Number - 6210G-xxP - (Purple)

3. Wireless Access - Leviton SlimLine 10gig UTP Patch Cord – Part Number - 6210G-xxG - (Green)

4. Security - Leviton SlimLine 10gig UTP Patch Cord – Part Number - 6210G-xxY - (Yellow)

PART 3 - Execution

3.1 Codes, Standards, Regulations

A. American National Standards Institute (ANSI)

B. American Society for Testing and Materials (ASTM)
   1. ASTM B 1 Standard Specification for Hard-Drawn Copper Wire
   2. ASTM B 8 Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
   3. ASTM D 1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
   4. ASTM D 709 Laminated Thermosetting Materials

C. Alliance for Telecommunications Industry Solutions (ATIS)

D. Building Industry Consulting Service International (BICSI)
   1. Telecommunications Distribution Methods Manual 14th Edition
   2. Outside Plant Design Reference Manual 6th Edition
   3. ANSI/BICSI Data Center Design and Implementation Best Practices
   4. NECA/BICSI 568-D Standard for Installing Commercial Building Telecommunications Cabling
   5. NECA/BICSI 607-D, Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings

E. Federal Communications Commission (FCC)
   1. FCC Part 15, Radiated Emissions Limits
   2. FCC Part 68, Connection of Terminal Equipment to the Telephone Network
   3. FCC Part 76, Cable Television Service

F. Insulated Cable Design Consultants Association (ICEA)
   1. ICEA S-87-640 Fiber Optic Outside Plant Communications Cable
   2. ICEA S-98-688 Broadband Twisted Pair, Telecommunications Cable Aircore, Polyolefin Insulated Copper Conductors
   3. ICEA S-99-689 Broadband Twisted Pair Telecommunications Cable Filled, Polyolefin Insulated Copper Conductors

G. International Electrotechnical Commission (IEC)

H. Institute of Electrical and Electronics Design Consultants, Inc. (IEEE)
   1. IEEE Standard IEEE Guide for Measuring Earth Resistance, Ground Impedance, and Earth Surface Potential of a Ground System
   2. IEEE Standard 1100 Recommended for practice for Powering and Grounding Sensitive
   3. Electronic Equipment in Industrial and Commercial Power Systems (IEEE Emerald Book)
   4. IEEE C2 Errata INT National Electrical Safety Code
   5. IEEE Std 100 The Authoritative Dictionary of IEEE Standards Terms

I. International Organization for Standardization (ISO)
   1. International Organization of Standardization/International Electrotechnical Commission (ISO/IEC)
   2. ISO/IEC 11801, Information Technology-Generic Cabling for Customer Premises,
   3. ISO/IEC 14763-1, Information Technology-Implementation and Operation of Customer Premises Cabling-Administration
   4. ISO/IEC 11801, Information Technology-Generic Cabling for Customer Premises
   5. ISO/IEC 14763-1, Information Technology-Implementation and Operation of Customer Premises Cabling-Administration

J. National Cable Television Association (NCTA)

K. National Electrical Manufacturers Association (NEMA)

1. NEMA C62.61 Gas Tube Surge Arresters on Wire Line Telephone Circuits

L. National Fire Protection Association (NFPA)
1. NFPA-70, National Electrical Code
2. NFPA-75, Protection of Electronic Computer Data Processing Equipment.
3. NFPA-101, Life Safety Code
4. NFPA-297, Guide on Principles and Practices for Telecommunications Systems
5. NFPA-780, Standard for the Installation of Lightning Protection Systems.

M. National Institute Standards and Technology (NIST)

N. Occupational Safety and Health Administration (OSHA)

O. Telecommunications Industry Association (TIA)
1. ANSI/TIA-568-D, Generic Telecommunications Cabling for Customer Premises.
2. ANSI/TIA-568-D, Commercial Building Telecommunications Cabling Standard.
3. ANSI/TIA -568-D, Balanced Twisted-Pair Telecommunications Cabling and Components Standard.
4. ANSI/TIA-568-D, Optical Fiber Cabling Components Standard.
5. ANSI/TIA–569-E Commercial Building Standard for Telecommunications Pathways and Spaces.
6. ANSI/TIA-606-D, Administration Standard for the Telecommunications Infrastructure.
7. ANSI/TIA-607-D, Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises.
8. ANSI/TIA-758-B, Customer-Owned Outside Plant Telecommunications Infrastructure Standard.

P. U.S. Department of Agriculture (USDA)
1. RUS 1755 Telecommunications Standards and Specifications for Materials, Equipment and Construction
2. RUS Bull 1751F-643 Underground Plant Design
3. RUS Bull 1751F-815 Electrical Protection of Outside Plant
4. RUS Bull 1753F-201 Acceptance Tests of Telecommunications Plant (PC-4)
5. RUS Bull 1753F-401 Splicing Copper and Fiber Optic Cables (PC-2)
6. RUS Bull 345-65 Shield Bonding Connectors (PE-65)
7. RUS Bull 345-72 Filled Splice Closures (PE-74)
8. RUS Bull 345-83 Gas Tube Surge Arrestors (PE-80)

Q. Underwriters Laboratories, Inc. (UL)
1. UL 510 Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape
2. UL 910 (NFPA 262) Applicable Flame Test

3.2 General requirements

A. In the event of any conflicts between documents referenced herein and the contents of this specification, the Contractor shall notify the Architect/Design Consultant in writing of any such occurrences before purchasing or installing any equipment or materials. The Architect/Design Consultant will notify the Contractor of any actions required to resolve these conflicts. Such actions may include but are not limited to: design changes, equipment, materials and/or installation changes. In any event Contractor shall not supersede specifications and standards from the latest NFPA and NEC publications. In the event of any conflicts between Standards and Codes the more stringent shall take precedence.

B. Contractor shall comply with the requirements of local Authority Having Jurisdiction (AHJ), State of Texas, the National Fire Protection Association (NFPA), and the National Electrical Code (NEC). If the Contractor identifies any item in the plans or specifications that will not strictly comply with the aforementioned laws, ordinances, and rules, the matter shall be referred to the Architect/Design Consultant for direction before proceeding with that part of the work.

C. The Contractor shall be responsible for coordination with other trades to ensure any conflicts or potential conflicts are resolved prior to any work beginning on the project.

D. The Contractor shall install the materials in accordance with these specifications and the manufacturer's installation guidelines.

E. No deviations from the plans or specifications shall be made without full consent in writing of the Architect/Design Consultant. The Contractor shall have written approval from the Architect/Design Consultant for any additional work beyond the Contract Documents prior to beginning such work. If the Contractor does not obtain written approval from the Architect/Design Consultant prior to proceeding with the work, the contractor shall not be reimbursed for the work.

F. The Contractor shall obtain written permission from the Architect/Design Consultant before proceeding with any work that would necessitate cutting into or through any part of the building structure such as, but not limited to girders, beams, floors, walls, roofs, or ceilings.

G. Contractor shall perform onsite coordination with the General Contractor, Structural, MEP, and Civil as required to discuss outside plant and inside plant clash detection with other trades. Contractor shall notify the Architect/Design Consultant a minimum of (2) weeks prior to beginning work and will participate in a pre-construction meeting with the Architect/Design Consultant to perform a walkthrough, review the scope of work, schedule, and escalation procedures.

H. The Contractor shall maintain a work area free of debris, trash, empty cable reels, scrap cable, etc., and dispose of such items on a daily basis and return the site to the original state of cleanliness. The Contractor shall not use Owner's facilities for the disposal of excess or scrap materials.

I. Equipment and materials installed by the Contractor shall be free of defects and damage.

J. Contractor shall be responsible for the repair of any damage caused by the contractor during the installation.

K. Contractor shall test all cables prior to installation. By failing to perform this testing operation, the Contractor shall accept the cable as compliant and assume all liability for the replacement of the cable at no cost to the Owner should it be found defective at a later date.

L. Contractor shall maintain a set of working specifications, design drawings, and record drawings to be kept on site at all times and shall update the record drawings with any changes on a weekly basis. Record drawings shall be made available for inspection at the request of the Architect/Design Consultant.

M. Equipment and materials shall be consistent throughout the installation. Where multiple units of the same type of equipment and materials are required, these units shall be a standard product with the same manufacturer and model number.

N. Equipment and materials shall be delivered and stored in accordance with the manufacturer's guidelines at the Contractor's expense.

O. Contractor shall make all stored equipment and materials available for inspection at the request of the Architect/Design Consultant.

P. All equipment and material used in the installation shall be approved by the manufacturer for the environment in which it is being installed.

Q. Cables shall be properly supported in accordance with industry standards at all times. Improperly supported cables shall be corrected by the Contractor at no cost to the Owner.

R. Contractor shall be responsible to properly protect information outlets from damage by other trades during construction.

S. Cables shall be routed at 90-degree angles to the building structure. At no time shall a diagonal pull be installed.

T. The Contractor shall not install cables in conduits or sleeves without nylon bushings. Cables installed through conduits or sleeves without nylon bushings shall be removed and replaced at no cost to the Owner.

3.3 System Requirements

A. The contractor is responsible for furnishing materials as required to provide a complete and functioning system. Quantities are not noted, so the information may be obtained from the technology drawings.

B. Inter-Building Cable Plant
   1. Fiber Optic Cable
      a. Multi-mode
         1) Contractor shall furnish and install fiber optic cables as indicated on the Drawings
         2) Contractor shall install a 10-foot service loop at the ends of each cable to be coiled, mounted, and stored on the wall above the ladder rack.
         3) Cables shall be routed utilizing the pathways as indicated in the technology drawings.
   2. Fiber Optic Termination
      a. Contractor shall terminate all installed fiber optic strands with fusion splice connectors and place into fiber optic enclosures with splice trays as indicated in the technology drawings.
      b. Contractor shall furnish fiber optic enclosures and coupler panels for all fiber optic strands and blank panels for all unused slots.
   3. Copper Cable
      a. High Pair Count Cable
         1) The Contractor shall furnish and install copper cables as indicated on the Drawings.
         2) The Contractor shall install a 10-foot service loop at the ends of each cable to be coiled, mounted, and stored on the wall above the ladder rack.
         3) Cables shall be routed utilizing the pathways as indicated in the technology drawings.
   4. High Pair Count Termination
      a. Building Entrance Terminals
         1) The contractor shall terminate copper cable pairs between the existing communications rooms on contractor furnished and installed building entrance terminals as indicated in the technology drawings.
         2) Contractor shall furnish and install all terminals fully populated with surge protection modules.
         3) Contractor shall ground and bond all cables and terminals.
      b. Wall-mounted Wiring Blocks
         1) The Contractor shall furnish and install wall mounted 110 wiring blocks and terminate cable whip from Building Entrance Terminal to this 110-block.
         2) The Contractor shall furnish and install tie cables from the protector block/110 block to contractor furnished and install category 5e patch panels.
         3) Contractor shall furnish and install tie cables/cross connects from the service provider high pair count copper cable to the owners equipment rack as required.

C. Intra-Building Cable Plant
   1. Fiber Optic Cable
      a. Multi-mode
         1) Contractor shall furnish and install plenum rated fiber optic cables as indicated on the technology drawings.
            a) Each fiber optic cable shall be installed inside a double cell of the fabric innerduct.
         2) Contractor shall install a 10-foot service loop at the ends of each cable to be coiled, mounted, and stored on the wall above the ladder rack.

3) Cables shall be routed utilizing the pathways as indicated in the technology drawings.

2. Fiber Optic Termination
   a. Contractor shall terminate all installed fiber optic strands with fusion splice connectors and place into fiber optic enclosures with splice trays as indicated in the technology drawings.
   b. Contractor shall furnish fiber optic enclosures and coupler panels for all fiber optic strands and blank panels for all unused slots.
3. Copper Cable
   a. High Pair Count
      1) The Contractor shall furnish and install copper cables as indicated on the Drawings.
      2) The Contractor shall install a 10-foot service loop at the ends of each cable to be coiled, mounted, and stored on the wall above the ladder rack.
      3) Cables shall be routed utilizing the pathways as indicated in the technology drawings.
4. High Pair Count Termination
   a. Wall-mounted Wiring Blocks
      1) The Contractor shall furnish and install wall-mounted 110-blocks to support all copper backbone pairs. Indicate proposed location on Shop Drawings.

D. Horizontal Cable
1. No horizontal cable shall be longer than two hundred ninety-five (295) feet. If any station cable will be longer than two hundred ninety-five (295) feet, Contractor shall stop installation of the cable and immediately notify Architect/Design Consultant in writing. If Contractor fails to notify the Architect/Design Consultant in writing, Contractor shall replace cable at no cost to the Owner.
2. The Contractor shall furnish and install horizontal cables within each Technology Region from the respective ER or TR to each outlet location as indicated in the technology drawings.
3. The Contractor shall install a 10-foot service loop to be coiled, mounted, and stored above the ladder rack in each respective Equipment Room or Telecommunications Room.
4. The Contractor shall provide a 2-foot service loop coiled and supported directly above the workstation outlet.

E. Horizontal Cable Termination
1. Contractor shall terminate cables as defined by the ANSI/TIA 568-D Commercial Building Wiring Standard with the EIA-568B sequence.
2. Workstations
   a. Contractor shall furnish and install modular jacks to terminate UTP horizontal cables.
   b. Contractor shall furnish and install faceplates, systems furniture faceplates, or surface-mount boxes to house modular jacks as indicated in the technology drawings.
      1) Any unused faceplate positions shall have the appropriate number and color of blanks installed.
3. Equipment Rooms / Telecommunications Rooms
   a. Horizontal Cable for Data
      1) Contractor shall furnish and install patch panels and horizontal cable managers to terminate horizontal data cables as indicated in the technology drawings.
      2) The Contractor shall provide and install separate modular patch panels for the cabling supporting the following devices:
         a) Network Access (Blue cabling and jacks)
         b) Security Camera Access (Yellow cabling and jacks)

c) Wireless Access (Blue cabling and jacks)

b. Horizontal Cable requiring lightning protection

1) Contractor shall furnish and install lightning protection on both ends of any cables on the exterior of the building as indicated in the technology drawings.

2) All lightning protection shall be installed per manufacturer's instructions including but not limited to placement and bonding requirements.

F. Patch Cables

1. Fiber

a. Equipment Rooms / Telecommunications Room

1) The Contractor shall furnish and store (1) patch cable in original manufacturer packaging for 75% of the strands terminated per Equipment Room / Telecommunications Room:

a) 100% of the patch cables shall be (2) meters in length and stored in the applicable Equipment Room / Telecommunications Room

2. Copper

a. Workstations

1) The Contractor shall furnish and store (1) patch cable in original manufacturer packaging for each cable terminated.

2) 100% of the patch cables shall be (15) feet in length and stored in the applicable Equipment Room / Telecommunications Room.

b. Equipment Rooms / Telecommunications Rooms

1) The Contractor shall furnish and store (1) patch cable in original manufacturer packaging for each cable terminated per Equipment Room / Telecommunications Room:

2) 100% of the patch cables shall be (length TBD) foot in length and stored in the applicable Equipment Room / Telecommunications Room

G. Cable Support

1. All cables shall be installed and supported in conduit systems, cable trays, cores, sleeves, etc. as indicated in the technology drawings.
2. When cables leave the main pathway systems as indicated on the technology drawings, they shall be installed and supported in Contractor furnished and installed j-hooks or adjustable cable supports.
3. No cable pathway shall exceed 40% fill ratio.
4. The contractor shall furnish a separate j-hook or adjustable cable support pathway for each cable type (data, paging/clock, and security).
5. J-hooks and adjustable cable supports shall be installed no more than five-feet (5') apart on center, using only manufacturer-approved installation methods and hardware.
6. J-hooks and adjustable cable supports shall be installed no higher than 3-feet above the accessible ceiling to allow for ease of access for future moves, adds and changes
7. Do not utilize ceiling grid support wire; support j-hooks via wall, structure, or threaded rod support to structure.
8. J-hooks shall be furnished with closure clips.
9. Maximum sag between supports shall not exceed twelve-inches (12").
10. Contractor shall establish j-hook and adjustable cable supports pathways and shall coordinate pathways with all other disciplines. Under no-circumstances shall these pathways be used to support other low-voltage applications not included in this specification.
11. Contractor shall provide and install horizontal cabling in unison with the construction process and prior to the gypsum ceiling being installed.
12. UNDER NO CIRCUMSTANCES SHALL ZIP TIES BE USED ON ANY HORIZONTAL CABLING.

13. Cable Dressing
    a. No nylon cable ties shall be used at any time during the installation of the cable.
    b. Above Ceiling
        1) Contractor shall furnish and install plenum-rated hook & loop straps in plenum-rated airspaces.
            a) The Contractor shall install no more than (1) hook & loop strap between each j-hook or saddle strap or at service loop locations.
    c. Equipment Rooms / Telecommunications Rooms
        1) The Contractor shall bundle all visible cables by type (blue Cat 6 for data, blue Cat 6A for WAPs, yellow for security, white for paging, etc) with Contractor furnished and installed hook & loop straps.
            a) Hook & loop straps shall be installed twenty-four (24) inches apart on center.

H. Equipment Rooms / Telecommunications Room Build-Out
    1. Plywood
        a. The Contractor shall furnish and install 8’ H x 4’ W x ¾” D sheets of AC grade fire-rated plywood as indicated in the technology drawings.
        b. The Contractor shall mount all plywood vertically starting at 24” AFF.
        c. The Contractor shall cover the plywood with two (2) coats of Contractor furnished white fire-retardant paint leaving exposed (1) fire rating stamp per sheet.
    2. Cable Runway (Ladder Type)
        a. Contractor shall furnish and install cable runway using manufacturer-approved hardware and installation methods as indicated in the technology drawings.
        b. Contractor shall furnish and install vertical sections of cable runway using manufacturer-approved hardware and installation methods to provide transition and support where cables enter or exit the room using a vertical pathway.
        c. Contractor shall furnish and install radius drops cross member and stringers above each rack using manufacturer-approved hardware and installation methods where cables exit the horizontal section of the ladder rack.
        d. Contractor shall ground and bond each cable runway section to the next utilizing ground straps and ensure metal-to-metal contact.
    3. Equipment Racks and Cabinets
        a. Contractor shall furnish and install equipment racks with vertical management using manufacturer approved hardware and installation methods as indicated in the technology drawings.
        b. Contractor shall secure relay racks to the concrete floor utilizing expandable concrete anchors.
        c. Contractor shall secure the equipment racks to the cable runway using cable runway elevation kits and manufacturer approved hardware and installation methods.
        d. Contractor shall bolt all equipment racks and vertical cable managers together.
        e. Contractor shall individually ground and bond each equipment rack and ensure metal-to-metal contact.
    4. Patch Panels
        a. Horizontal Cabling patch Panels shall be installed as indicated in the Technology Drawings.

I. Grounding and Bonding
    1. General Requirements:
        a. Ensure metal-to-metal contact for all terminations.
        b. All materials shall be UL Listed.

c. Cable-to-cable connections and cable-to-building steel connections shall be exothermic welds. All other connections shall be made with UL Listed compression 2-hole lugs with anti-oxidation compound, utilizing both lug openings.

d. Only one lug shall occupy a hole on the busbar. No stacking lugs or “double lugging” shall be permitted.

e. Bonding conductors shall be sized based on length per the table on the Drawings; minimum size #6 AWG and maximum size 750kcmil.

f. For Communications Rooms / Data Centers with a raised floor, provide a supplementary bonding grid (SGB) below the raised floor comprised of the following:

1) Bare copper conductor around the perimeter of the room

2) 12”x4” TGB/SBB, bonded to two points of the perimeter conductor and to the TGB/SBB above the access floor

3) Bond all piping and conduit entering raised floor at the perimeter.

4) Bond floor pedestal to Computer Room Air Conditioning Unit (if located in Communications Room)

5) Bare copper conductor between every four stringers, running the length/width of the room in both directions; bond to every fourth pedestal in both directions and to perimeter bonding conductor.

6) Bond floor pedestal to Power Distribution Unit feeder conduit below raised floor.

2. Telecom Bonding System shared with Electrical Ground System – Compliant with BICSI TDMM

a. For a building without structural steel, Telecommunications Bonding Backbone is not required. The TMGB/PBB shall be bonded to the Electrical Ground System via a Bonding Conductor for Telecommunications. TGB/SBB shall be bonded to the grounding busbar of the serving electrical panelboard. Bonding conductor routing shall be indicated on Record Drawings.

b. Provide label above TGB/SBB shall indicated name of electrical panelboard and the room it is located. Indicate routing on pre-construction Shop Drawings, and update with final installed routing as part of As-Built Drawings.

3. Main Communication Room (MDF / Server Room) requirements

a. Install TMGB/PBB at 84-inches above finished floor.

b. Bonding Conductor for Telecommunications (BCT)

1) Division 26 Contractor shall provide Bonding Conductor for Telecommunications from the Electrical Ground System to the TMGB/PBB in the MDF Room.

2) BCT conductor size shall be sized based on length per the table on the Drawings and shall be no smaller than the largest TBB conductor. If installed underground, install in dedicated 2-inch diameter conduit.

c. Provide bonding conductors to the following equipment within the Communication Room (where available/installed):

1) Structural steel or support beams located within the room.

2) If electrical distribution panelboard serving the Communications Room is located within the Communications Room, bond TGB/SBB to ground bus of the panelboard.

3) Overhead ladder rack

4) Equipment racks, cabinets, and enclosures

5) Surge protectors / building entrance terminals

6) Exposed cable shields

7) Continuous metallic conduits for low-voltage cabling that stub into the Communication Room

8) Any additional equipment or pathways where bonding/grounding is recommended by the equipment manufacturer or the referenced standards (TIA 607 and NECA/BICSI 607).

4. Secondary Communication Rooms (IDFs / Data Rooms)
   a. Install TGB/SBB at 84-inches above finished floor.
   b. Provide bonding conductors to the following equipment within the Communication Room (where available/installed):
      1) Structural steel or support beams located within the room.
      2) If electrical distribution panelboard serving the Communications Room is located within the Communications Room, bond TGB/SBB to ground bus of the panelboard.
      3) Overhead ladder rack
      4) Cable trays in corridor
      5) Equipment racks, cabinets, and enclosures
      6) Surge protectors / building entrance terminals
      7) Exposed cable shields
      8) Continuous metallic conduits for low-voltage cabling that stub into the Communication Room
      9) Any additional equipment or pathways where bonding/grounding is recommended by the equipment manufacturer or the referenced standards (TIA 607 and NECA/BICSI 607).

J. Wire-mesh cable tray
   1. Coordinate with all other disciplines to ensure cable tray routing and installation is coordinated with other systems.
   2. Coordination with all other disciplines to ensure the 12-inch clearance above the tray is maintained.
   3. Any elevation changes shall have radius drops installed to support the cables properly.
   4. Install cable trays parallel with or at right angles to ceilings, walls, and structural members. Utilize 45-degree off-sets/routing to change elevation and horizontal routing.
   5. Provide supports to resist forces of 0.5 times the equipment weight in any direction and 1.5 times the equipment weight in the downward direction.
   6. Where cable trays encounter a non-fire-, smoke-, or acoustically-rated wall, cut opening through wall to facilitate continuous cable tray installation through wall.
   7. Where cable trays encounter fire, smoke, or acoustically-rated wall, stop cable tray and provide Fire-or Smoke-Rated Pathway Devices. Provide number of devices to match square-inch capacity of cable tray. Devices shall be ganged together with manufacturer-specific accessory.
   8. Ground and bond cable tray in accordance with NFPA 70, TIA-607, and NECA/BICSI-607.
      a. Bond cable tray to the Telecom Ground Bar in each Communications Rooms. Utilize #6 AWG conductor for lengths up 13 feet, a #4 AWG conductor for lengths of 14 to 20 feet, and a #3 AWG conductor for lengths of 21 to 26 feet. Refer to TIA 607 standard for conductor size requirements for lengths longer than 26 feet.
      b. Provide ground lugs between each section of cable tray to ensure electrical continuity of cable tray installation. Where cable tray sections are separated by conduit or firestopping sleeves, provide #6 AWG bonding jumper between cable tray sections.
   9. Cable Tray Supports
      a. Cable tray shall be supported by a trapeze or wall support brackets. No center support brackets shall be allowed.
      b. A minimum of 3/8-inch all-thread shall be used for trapeze supports.

c. Support in accordance with manufacturer recommendations but at not more than 10 foot intervals.
d. Cable tray shall be no less than 3-inches above a lay-in ceiling.
e. Cable tray shall be rigidly supported and level.
f. All-thread shall be covered from the attachment to the trapeze system to 3-inches above the tray to protect the cables from being chaffed.
g. All supports shall attach to structure or a rigid surface such as a plywood backer in a sheet rock wall.
h. Supports shall not be shared with any other discipline.

K. Firestopping
1. Fire-Rated Pathway Devices
a. Provide Fire-Rated Pathway Device(s) wherever Communications cabling routed above accessible ceiling needs to be routed through a fire-rated wall. Quantity and size of devices shall be sized per manufacturer's published cable fill counts, leaving 25% spare capacity.
b. Coordinate quantity, size and locations with other Division 27 Subcontractors and indicate quantity, size, location, product make and model number, and UL System number on Pre-Construction Shop Drawings.
c. Coordinate quantity, size and locations with other Division 27 Subcontractors and indicate quantity, size, location, product make and model number, and UL System number on Pre-Construction Shop Drawings.
d. Affix adhesive wall label immediately adjacent to devices to communicate to future cable technicians, authorities having jurisdiction and others the manufacturer of the device and the corresponding UL System number installed.
2. Firestopping for Conduits
a. Provide firestopping components as part of a UL System for all conduit penetrations through fire-rated and smoke-rated walls and floors.
b. Coordinate locations and UL System with other Division 27 Subcontractors and indicate locations and UL System number on Pre-Construction Shop Drawings.
c. Affix adhesive wall label immediately adjacent to devices to communicate to future cable technicians, authorities having jurisdiction and others the manufacturer of the device and the corresponding UL System number installed.
3. Firestopping for Backboxes
a. Provide firestopping component(s) as part of a UL tested/approved solution for backboxes located in fire-rated and smoke-rated walls.
b. Coordinate locations with other Division 27 Subcontractors and indicate locations on Pre-Construction Shop Drawings.
4. Smoke-Rated / Acoustical Pathway Device
a. Provide Smoke-Rated Pathway Device(s) wherever Communications cabling routed above accessible ceiling needs to be routed through a smoke-rated wall or through a wall of a Noise Critical Room.
b. Quantity and size of devices shall be sized per manufacturer's published cable fill counts, leaving 40% spare capacity.
c. Coordinate quantity, size and locations with other Division 27 Subcontractors and indicate quantity, size, location, product make and model number, and UL System number on Pre-Construction Shop Drawings.
d. For smoke-rated partitions: Affix adhesive wall label immediately adjacent to devices to communicate to future cable technicians, authorities having jurisdiction and others the manufacturer of the device and the corresponding UL System number installed.
5. Fire-rated Conduit (Circuit Integrity) Wrap
a. Provide Fire-rated Conduit (Circuit Integrity) Wrap for certain Communications conduits for the following systems:

1) Section 275129 Two-Way Communications System
2) Section 275319 Emergency Responder Radio Coverage (ERRC) DAS

b. Coordinate conduit size and lengths requiring wrap with Subcontractors of those sections prior to Bid and include cost to provide that wrap in the Bid.

L. System Labeling

1. Contractor shall verify room numbers and confirm the final room numbering scheme prior to generating any labels.
2. Horizontal Cables shall be labeled within (12) inches from the termination point inside the Equipment Room/Telecommunications Rooms.
3. Horizontal Cables shall be labeled within (6) inches from the termination point at the workstation end.
4. Backbone Fiber and Copper Cables shall be labeled within (12) inches of the visible end of the jacket and at each pull point location. If passing through an IDF it will be labeled when entering and leaving that IDF.
5. Fiber Innerduct shall be labeled within (12) inches of the point of entry of the fiber optic enclosure and at each pull point location. If passing through an IDF it will be labeled when entering and leaving that IDF.
6. Bonding conductors shall be labeled within (12) inches from their termination point.
7. Cables shall be labeled identically at both ends.
8. Equipment Racks
   a. Equipment racks in each Equipment/Telecommunication Room shall be labeled in sequential numeric order.
      1) Labels shall be centered on the top front of the equipment rack.
9. Cabinets
   a. Cabinets in each Equipment/Telecommunication Room shall be labeled in sequential numeric order.
      1) Labels shall be centered on the top front of the Cabinet.
10. Fiber Optic Enclosures
    a. Fiber optic enclosures shall be labeled alpha-numeric starting with the 1st fiber optic enclosure in the top of the 1st equipment rack.
    b. A label for each terminated strand shall be securely placed inside each fiber optic enclosure.
11. Backbone Cable
    a. Fiber Optic Cable
       1) Fiber optic backbone cable labels shall contain the cable origin room number, the cable destination room number, fiber strand numbers, and type (i.e. B126-A118/001-012MM).
       2) Fiber optic couplers panels in fiber enclosures shall be labeled at each end by strand denoting building code, Equipment Room and/or Telecommunications Room, enclosure number, and strand number to and from respectively (i.e. B126/01/01-12 – A118/01/01-12).
    b. High Pair Count Copper Cable
       1) For high pair count copper backbone cables, the label scheme shall contain, cable origin room number, the cable destination room number, and cable pairs (i.e. B126-A118/001-025).
12. Horizontal Cable
    a. Inside Equipment Rooms
       1) Horizontal cables shall be labeled at each end with the destination end and origin room number, patch panel number, and port number. (i.e. B126-B127-A01).

2) Patch panels in each closet shall be labeled sequentially starting with the first Patch Panel in the top of the first relay rack (A, B, C, D, E, etc.).
3) All patch panels will indicate the room number along with the patch panel port designation. The labels shall be mechanical labels that are neatly printed with uniform font and evenly spaced across the patch panel. Room numbers will be in sequential order throughout the panels as indicated on the drawings.
4) 110-type blocks shall contain the destination room number, pair numbers, and binder pair number under each pair termination. (example)
a) 110-type block labels shall be printed on product-specific label strips and placed into label holders.

13. Workstation Faceplates
a. Cables and wall plates shall be labeled denoting origin, Equipment Room/Telecommunications Room Number, Patch Panel, 110-type termination block, and Port Number. (i.e. B127-A01).
14. TMGB/PBB and TGB/SBB
a. TMGB/PBB and TGB/SBB shall be labeled with a unique identifier (i.e. TMGB/PBB-B126, TGB/SBB-A118).
15. Bonding Conductors
a. The following conductors shall be labeled at each end with the destination end and origin room number (i.e. B126 – IDFA118).
1) Bonding Conductor for Telecommunications
2) Telecommunications Bonding Backbone
3) Grounding Equalizer

3.4 Testing Requirements

A. Fiber Optic Cable
1. Installed strands shall be tested and certified in accordance with industry standards.
2. Only Manufacturer Certified Technicians shall perform testing.
3. The Contractor shall test and certify all fiber optic cable strands with approved field tester(s) that are within their calibration period. The Contractor shall be liable for all re-testing required in the event tests are performed with non-approved test equipment or tester(s) that are not within their calibration period.
4. The Contractor shall provide calibration results from the manufacturer showing the current calibration of the testers.
5. The Contractor shall notify the Architect/Design Consultant a minimum of five (5) days in advance to observe cable testing.
6. The Architect/Design Consultant may randomly select 5% of the installed strands for test verification purposes. The Contractor shall re-test these strands in the presence of the Architect/Design Consultant and the results shall be compared to the previously Contractor submitted test results. In the event that any of the verification tests differ in results from the previously submitted test results, all testing shall be declared a failure and the Contractor shall re-test 100% of the installed strands at no cost to the Owner.

B. Copper Backbone Cable
1. Installed pairs shall be tested and certified in accordance with industry standards.
2. Only Manufacturer Certified Technicians shall perform testing.
3. The Contractor shall test and certify all copper pairs with approved field tester(s) that are within their calibration period. The Contractor shall be liable for all re-testing required in the event tests are performed with non-approved test equipment or tester(s) that are not within their calibration period.
4. The Contractor shall provide calibration results from the manufacturer showing the current calibration of the testers.

5. The Contractor shall notify the Architect/Design Consultant a minimum of five (5) days in advance to observe cable testing.
6. The Architect/Design Consultant may randomly select 5% of the installed pairs for test verification purposes. The Contractor shall re-test these pairs in the presence of the Architect/Design Consultant and the results shall be compared to the previously Contractor submitted test results. In the event that any of the verification tests differ in results from the previously submitted test results, all testing shall be declared a failure and the Contractor shall re-test 100% of the installed pairs at no cost to the Owner.

C. Category 6 and 6A UTP Cable
1. Cable links shall be tested in accordance with industry standards.
2. Only Manufacturer Certified Technicians shall perform testing.
3. The Contractor shall test and certify the structured cable system with approved field tester(s) that are within their calibration period. The Contractor shall be liable for all re-testing required in the event tests are performed with non-approved test equipment or tester(s) that are not within their calibration period.
4. No Fail or *Pass results will be accepted.
5. The Contractor shall notify the Architect/Design Consultant a minimum of five (5) days in advance to observe field testing.
6. The Architect/Design Consultant may randomly select 5% of the installed links for test verification purposes. The Contractor shall re-test these links in the presence of the Architect/Design Consultant and the results shall be compared to the previously Contractor submitted test results. In the event that any of the verification tests differ in results from the previously-submitted test results, all testing shall be declared a failure and the Contractor shall re-test 100% of the installed links at no cost to the Owner.

D. Grounding and Bonding
1. Main Building Ground
a. Coordinate with electrical contractor and provide a copy of their test results for the main building ground. The results shall be below 25 Ohms.
2. Two-Point Ground/Continuity Testing
a. Prior to the two-point ground testing, a visual inspection shall be performed to verify that the bonding and grounding system is installed according to the drawings and specifications and in compliance with the TIA-607-D Standard.
b. All testing shall be conducted prior to any active equipment is installed.
c. The Contractor shall use an earth ground resistance tester that is configured for a continuity test. This is also known as a two-point tester or a “dead earth” test.
d. Prior to the two-point continuity test conduct a voltage test to ensure there is no stray voltage in the system.
e. The testing shall include but is not limited to the following points.
1) Building electrical grounding electrode and the TMGB/PBB.
2) TGMB/PBB TGB/SBB to electrical ground in ER/TR.
3) TGMB/PBB TGB/SBB to the building steel (if present).
4) TMGB/PBB to each TGB/SBB.
5) Building steel (if present) to the electrical ground.
f. Per the TIA-607-D, the maximum value for resistance between any point in the telecommunications bonding and grounding system and the building’s electrical grounding electrode system is 100 milliohms. In the case of long TBB and Grounding Equalizer conductor runs, the resistance of the conductor must be factored into the total resistance. For example 1 km of a No. 3/0 conductor has a resistance of 0.2028 ohms. (0.06180 ohms per 1000 ft.)
g. The Contractor shall notify the Architect/Design Consultant a minimum of five (5) days in advance to observe field testing.

3.5 Project Closeout Documentation

A. As-Built Drawings
   1. Drawings shall be provided to the Architect/Design Consultant at the time of substantial completion. Final payment will not be recommended until drawings are received and approved by the Architect/Design Consultant.
   2. Provide Drawings depicting the condition of the structured cabling system as installed.
   3. As-Built drawings shall be produced in AutoCAD 2017 or higher and provided in hard-copy and electronically in .dwg and PDF format.
   4. Drawings shall retain the formatting and title block of the original drawings as issued by the Architect/Design Consultant.
   5. Drawings shall be provided utilizing the original scale and shall include the exact dimensions and locations of all equipment room/telecommunication room layouts, wall elevations, equipment rack elevations, ladder racks, cable tray, sleeves, backbone and horizontal cable pathways, workstation locations, and labeling scheme.
   6. A laminated copy of the telecommunications room service region with the labeled work areas outlet shall be provided and hung in each telecommunications room. Drawing size will be 30”x42”.

B. Test Documentation
   1. Test documentation shall be provided to the Architect/Design Consultant at the time of substantial completion. Final payment will not be recommended until these test results are received and approved by the Architect/Design Consultant.
   2. Provide test documentation for the structured cabling system as installed.
   3. Test results shall be provided in original electronic format (i.e., manufacturer’s proprietary testing software along with applicable reader software) and PDF electronic format.
   4. Test documentation shall be bound, sectioned, and tabbed in the following sequence as applicable:
      a. Tester(s) Calibration Certificate(s)
      b. Inter-Building Backbone Fiber Optic Cable
      c. Inter-Building Backbone Copper Cable
      d. Intra-Building Backbone Fiber Optic Cable
      e. Intra-Building Backbone Count Copper
      f. Horizontal Category 3 Cable
      g. Horizontal Category 5e Cable
      h. Horizontal Category 6 Cable
      i. Horizontal Category 6A Cable
      j. Main Building Ground
      k. Two-Point Ground/Continuity Test

C. Manufacturer’s Performance Certification
   1. Certificate shall be provided to the Architect/Design Consultant at the time of final system acceptance. Final payment will not be recommended until the certificate of certification is received and approved by the Architect/Design Consultant.
      a. The manufacturer of the solution shall furnish a performance certification as per the specifications starting at final system acceptance.
      b. One original and two copies of the Manufacturer’s Certificate shall be provided.

D. Manufacturer’s Product Warranty
   1. Certificate of product warranty shall be provided to the Architect/Design Consultant at the time of final system acceptance. Final payment will not be recommended until this certificate of product warranty is received and approved by the Architect/Design Consultant.
      a. The manufacturer of the solution shall furnish a product warranty as per the specifications starting at final system acceptance.

b. One original and two copies of the Manufacturer's product warranty shall be provided.

E. Contactor's Statement of Warranty

1. Statement of warranty shall be provided to the Architect/Design Consultant at the time of substantial completion. Final payment will not be recommended until statement of warranty is received and approved by the Architect/Design Consultant.
   a. Contractor shall furnish a minimum of a one (1) year warranty on all materials, labor and workmanship starting at final system acceptance.
   b. One original and two copies of Contractor's warranty terms and conditions to include contact information (i.e. Contractor name, Point of Contact, address, phone number and email address) and start and end date for warranty call outs.

END OF SECTION

SECTION 280001 - BASIC REQUIREMENTS FOR LOW-VOLTAGE 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.

B. Drawings and Specifications
1. Division 28 specifications are written in imperative and streamlined format. This imperative language is directed to the Contractor. The word "shall be" shall be included by inference where a colon (:) is used within sentences and phrases.

C. Codes and Standards
1. Work shall comply with the local city codes and ordinances, the regulations of state authorities having lawful jurisdiction and the codes, statues and reference standards identified within these Specifications. These Specifications shall not be construed as negating the regulations or requirements of lawful jurisdictions.
2. Where Specifications require materials or equipment exceeding the minimum requirements of applicable codes and ordinances, the requirements of these Specifications shall take precedence.

1.2 DEFINITIONS & ABBREVIATIONS

A. DEFINITIONS
1. Contract Documents - Drawings and the project manual, including Specifications.
2. Install: to set in place in position for service.
3. Furnish: to supply.
4. Provide: to install and furnish.
5. City - When used in an otherwise non-specific reference anywhere in the Contract documents, City is defined to refer to the local municipal authority governing the project address or the City whose ETJ includes the project address.

B. ABBREVIATIONS
1. ETJ - Extra-Territorial Jurisdiction.
2. NFPA - National Fire Protection Association
3. NEC - National Electric Code (NFPA-70)
4. NESC - National Electric Safety Code
5. NECA - National Electrical Contractor's Association
6. NETA - InterNational Electrical Testing Association
7. NRTL - Nationally Recognized Testing Laboratory
8. UL - Underwriters Laboratories
9. FM - Factory Mutual
10. TIA - Telecommunications Industry Association
11. EIA - Electronics Industry Alliance

12. BICSI - Building Industry Consulting Service International
13. RCDD - Registered Communications Distribution Designer
14. NICET - National Institute for Certification in Engineering Technologies

1.3 SUMMARY ORGANIZATION

A. PART 1 of This Section Includes:
   1. Equipment coordination and installation.
   2. Submittal requirements.

B. PART 2 of This Section Includes:
   1. Substitution requirements.

C. PART 3 of This Section Includes:
   1. Common Requirements for Installation
   2. Quality Assurance requirements.

1.4 LOW-VOLTAGE SYSTEMS EQUIPMENT COORDINATION AND INSTALLATION

A. Pre-installation planning: Coordinate arrangement, mounting, and support of equipment as follows:
   1. The equipment shall be arranged to facilitate service, maintenance, and repair or replacement of components and equipment.
   2. Equipment shall not be installed below piping or ductwork.
   3. Allow right-of-way within the plenum for building systems in the following hierarchy:
      a. Piping and ductwork installed at required slope.
      b. Busway
      c. Ductwork
      d. Cable Tray
      e. Feeder conduit
      f. Branch conduit
      g. Cabling not installed in conduit

1.5 SUBMITTAL REQUIREMENTS

A. Provide all submittals associated with a system at the same time.

B. Submittals shall be provided in binders and arranged in sequence by Specification section number. Provide submittals only for specification sections that list this requirement.
   1. Provide tabs for each section, labeled to match the associated specification. The page after each tab section shall contain a typed list of any exceptions that the Contractor is proposing.
   2. Each page of the submittal shall be a clear copy or scan, indicating items and options proposed for use in the project with a graphical arrow. Items included on a submittal page that are not proposed for use shall be deleted with strike-through or other acceptable method that clearly distinguishes the proposed from non-relevant information.

C. Subject to the requirements in Division 1, at the Contractor's option, submittals may be provided in PDF form.

1. All format and informational requirements for submittals in binders apply to PDF submittals.
2. Multiple files may be submitted; however, these must be organized into a consistent format.
3. PDF submittal shall include a table of contents with page numbers listed for the beginning of each section.
4. Additionally, the PDF shall be formatted to include tab or chapter shortcuts, labeled with the associated specification section. These shortcuts shall allow the reader to jump to a tab or chapter associated with beginning of each specification section with a single action.
5. At engineer's request, the contractor shall submit hard copy version in accordance with requirements outlined above.

PART 2 - PRODUCTS

2.1 GENERAL MATERIALS AND EQUIPMENT REQUIREMENTS

A. Materials and equipment shall conform to National Electrical Code requirements and shall be listed by Underwriters Laboratories, Inc. (UL). UL listing will be accepted as evidence that the material or equipment conform to the standards of that agency. In lieu of this listing, submit a statement from a nationally recognized testing agency, indicating that products have been tested in accordance with UL criteria and that the materials and equipment comply with Contract requirements.

B. Materials and equipment: standard catalog products of manufacturers regularly engaged in the manufacture of products conforming to these Specifications and essential duplicates of materials and equipment that have been in satisfactory use at least two (2) years prior to the date of receipt of bids. Custom fabricated items shall be fully described using Drawings and technical data sufficient to demonstrate compliance with the Contract Documents.

2.2 SUBSTITUTIONS

A. Basis of Design - For products specified in part 2.1 of the associated specification section, as "Basis of Design", that is herein defined as the standard level of product that is required for the project.
   1. The use of term Basis of Design in these specifications is intended to allow the Contractor to propose use of non-specified manufacturer's products, provided that the proposed substitute is of equal or greater construction material, workmanship, quality, performance, and manufacturer support. If the product is visible on the project, aesthetic considerations are also considered as a significant factor.
   2. During the bid process, the Engineer will not evaluate products and provide approval prior to the bid date on proposed substitute products. If the Contractor wishes to propose substitutions, the Engineer will evaluate the successful Contractor's proposed alternates during the submittal review process. The Engineer will take no exception to the use of individual products determined to be equal. That decision may be the result of consultation and input from other members of the design team. If a product is not determined to be equal, it will be rejected and another product that is equal to the basis of design shall be re-submitted by the

Contractor. The Engineer will not evaluate more than two substitution attempts before the Contractor is required to submit the specified product.

3. If the Contractor proposes product substitutions that may not be equal to the specified product, but there are cost savings associated with the use of the proposed substitute, then the Contractor should propose these as part of a VE (Value Engineering) process, with line item cost savings identified for each product substitution proposed. With information on line item costs, the design team may determine if the proposed substitutes, though not equal, represent a better value and these *may* be recommended for use.

B. Substitutions are generally not allowed for products specified in the associated specification section when listed as "Provide products by one of the following". If there is a concern about delivery schedules from the manufacturers listed or other factors, these special case substitutions will be considered individually during the submittal phase.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR INSTALLATION

A. Install in accordance with approved equipment submittal layouts.

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

C. Coordinate location of access panels and doors for items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames." Coordinate location of access panels and doors with Architect prior to the associated equipment rough-in.

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping.".

E. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

3.2 QUALITY ASSURANCE

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

2. Refer to testing requirements associated within each system's product specification sections.

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

D. Prepare test and inspection reports, including a certified report that identifies system included and that describes results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION 280510

SECTION 281300 - ACCESS CONTROL SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. This section identifies the requirements, technical design, and specifications for the access control system at the Kendall County EMS Station NO. 3, located in Bergheim, Texas ("Owner"). The access control system as specified is an Industry-Standard access control system and includes access control server, access control software, badge printer, control panels, sub-controller panels, card readers, credentials, door position sensors, request to exit devices, cabling, power supplies, and any associated software, hardware, or licensing as specified.

B. It is the Contractor's responsibility to review this specification and associated project specifications and drawings in their entirety, prior to bidding on the project. By bidding on this project, the contractor acknowledges that they have read and fully understand these specifications, with no exceptions. Contractor shall review the drawings, specifications, and existing conditions prior to bidding on the project. Any discrepancies shall be brought to the attention of the Architect / Design Consultant via request for information (RFI) in writing for evaluation and or clarification. If these items are not brought to the attention of the Architect / Design Consultant the more costly or difficult manner, and the better quality or greater quantity of work shall be provided by the contractor in accordance with the Architect's / Design Consultant's interpretation at no additional cost to the owner.

C. Contractor shall furnish and install all materials, equipment, and labor necessary to provide a complete and functional turn-key access control system regardless of any items not listed or described in this specification or associated drawings.

D. Requirement Sections Table of Contents

1.3 Contractor Experience Requirements

1.4 Submittal Requirements

2.1 Products – General Requirements

2.2 Acceptable Manufacturers

3.1 Codes, Standards and Regulations

3.2 Execution - General Requirements

3.3 Coordination Requirements

3.4 System Requirements

3.5 Testing Requirements

3.6 Training Requirements

3.8 Substantial Completion

3.9 Project Closeout Documentation

1.2 RELATED REQUIREMENTS

A. The Drawings, Specifications, General Conditions, Supplementary General Conditions, and other requirements of Division 1 apply to the work specified in Division 28 and shall be complied with in every respect. The Contractor shall examine all the items which make up the Contract Documents and shall coordinate them with the work on the project.

1.3 CONTRACTOR EXPERIENCE REQUIREMENTS

A. The Contractor shall be a certified **Avigilon** Access Control System Partner prior to submitting a bid for the work.

B. The Contractor shall possess all relevant **Avigilon** Manufacturer Certifications (i.e. access control systems, hardware installation, software installation and programming) for both the company and individual technicians prior to submitting a bid for the work.

C. The Contractor shall have an **Avigilon** manufacturer certified technician onsite throughout the duration of the installation phase of the project.

D. The Contractor's Project Manager shall be dedicated to this project for the duration of the project and shall be available for all onsite coordination meetings.

E. The Contractor shall have been in business for a minimum of five (5) years.

F. The Contractor shall have a local office with local technicians and an adequate workforce to complete this project within a 75-mile radius of the project site.

G. The Contractor shall have completed a minimum of five (5) projects similar in size and scope to the Owner's installation, where the systems have been in continuous satisfactory operation for at least one (1) year.

H. Subcontractors shall be identified at the time of bid and comply with the requirements and intentions of these specifications, associated drawings, and related contract documents.

1.4 SUBMITTAL REQUIREMENTS

A. Bid / Proposal Submittal

1. Contractor shall provide as part of their bid/proposal:

a. Breakdown of proposed parts and labor required for the completion of the project. Include documentation showing annual licensing cost of ownership.

b. Proposed construction schedule in a Gant chart format

c. Contractor Safety Plan detailing safety practices around the jobsite.

d. Contractor QA / QC process detailing processes and procedures to ensure quality workmanship during installation and troubleshooting.

e. A detailed description of the installation team(s) that would perform the work.

f. A resume for each of the key project personal.

g. A list of all Sub Contractors and their scope of work shall be identified at the time of bid. All Sub Contractors will fully comply with the requirements and intentions of these specifications, associated drawings, and related contract documents.

h. Cost for spare parts as outlined in these specifications.

i. Cost for unit pricing as outlined in related specifications.

B. Pre-Installation Submittal

1. Contractor shall not order, purchase, or install any equipment until pre-installation submittals have been accepted in writing by the Architect / Design Consultant.

2. The Contractor is responsible for notifying and obtaining written approval via RFI from the Architect / Design Consultant / Owner of any proprietary devices, software, and/or installation processes.

3. Contractor is responsible for obtaining permitting as required in accordance with the authority having jurisdiction (AHJ), local, city, state, federal, and/or applicable law requirements.

4. Contractor shall ensure submittals are submitted in 15 business days of award to ensure all products can be ordered and received on site in order to not cause any delays. Any products having long lead times (more than 60 days) that may negatively impact the schedule shall be clearly identified in writing so the review and approval can be expedited.

5. All submittals shall be submitted in the same sequence as they are listed in the specifications (i.e. product data in the sequence items are listed in the product data section, manufacturer product certifications for company, manufacturer product certifications for installers, etc.). Submittals not in the proper sequence will not be approved.

6. Contractor shall provide the following as part of their submittal:

   a. Manufacturer product data sheets for each proposed system component.

      1) For product data sheets containing more than one (1) part number or product, the Contractor shall clearly identify the specific part number or product being submitted. Product data sheets without the part number clearly identified will not be approved.

      2) Contractor shall identify any products that are discontinued, end of life, or near end of life, and shall propose equal alternate to the discontinued product in writing.

   b. Manufacturer Product Certifications for Company.

   c. Manufacturer Product Certifications for Installers.

   d. Manufacturer Warranty letters.

   e. Documentation indicating that Contractor has been in business for (5) years.

   f. Address of Contractor's local office within a 75-mile radius of the project site.

   g. Quantity of full-time, local technicians within a 75-mile radius of the project site.

   h. List of five (5) contractor-installed projects of a similar size and scope that have been in operation for at least (1) year. The Contractor shall provide the following information for each project: Project Name, Project Location, Project Start Date, Project Completion Date, Project Start Cost, Project Completion Cost, Brief Description of Project, Client Point of Contact Name and Phone Number.

   i. List of completed and ongoing projects with the Owner. The Contractor shall provide the following information for each project: Project Name, Project Location, Project Start Date, Project Completion Date, Project Start Cost, Project Completion Cost, and Brief Description of Project.

   j. List of subcontractors performing any work on the project. List shall clearly identify the subcontractor's legal name and address, the scope of work to be performed by the subcontractors and the overall percentage of the project being provided by the subcontractor. If there are no subcontractors performing any work on the project, submit a statement on company letterhead clearly indicating no subcontractors will be performing any work on this project.

   k. Manufacturer's certification letter confirming that the proposed access control system components do not have any known cybersecurity notices, bulletins, or alerts. If a vulnerability is discovered, the contractor shall notify the Architect / Design Consultant within 24 business hours. Provide the make and model of the associated equipment and the vulnerability.

   l. Manufacturer cybersecurity hardening guide. If one is not available, provide documentation from the manufacturer stating such.

   m. A complete set of shop drawings to include at minimum but are not limited to:

      1) Proposed and/or samples of original contractor security schedules. Schedules are not to be copy/paste of schedules provided within the contract documents. Schedules proposed shall be utilized as part of As-Built drawings with coordination with Div. 27 for additional information as required for network components.

         a) Device and equipment schedules shall include at a minimum but are not limited to:

(1) Device Label

(2) Device Type

(3) Device Power Requirements

(4) Terminating MDF / IDF / Panel Location

b) Additional networking information as required to include:

(1) Rack

(2) Network switch

(3) IP addresses

(4) Patch panel

(5) Surge/lighting protection

(6) Power source

2) Elevation and Topography Drawings to illustrate the associated devices and equipment and the heights at which they will be installed.

3) Signal Flow Diagram including full security topology.

n. Supplemental documents to include at a minimum but are not limited to:

1) Contractor Safety Plan detailing steps Contractor will take to ensure a safe work environment.

2) Contractor QA/QC Document to include bench testing / initial configuration of all critical system components including but not limited to:

a) System Server(s)

b) Cameras

c) Contractor Furnished Workstations (if applicable)

3) Construction Schedule in a Gant chart format

4) Contractor Cybersecurity Hardening Guide detailing Contractor's internal policies for preventing the introduction of cyberthreats to the Owner's technology / security infrastructure.

a) Contractor Certification Letter utilizing company letterhead detailing the company policies and procedures.

b) Contractor shall provide a cybersecurity plan detailing their internal policy for preventing the introduction of cyberthreats to the Owner's technology / security infrastructure.

PART 2 - PRODUCTS

2.1 General Requirements

A. The following sections specifically list the acceptable equipment types and items for this project.

B. All software, hardware, and equipment (from the date of RFP) shall be tested, currently available and commercially off the shelf product. (COTS).

C. All wiring, equipment, and installation materials shall be Commercial Grade, new, and of the highest quality to meet or exceed the performance and features of the equipment and devices specified herein.

D. Written approval must be obtained from the Architect / Design Consultant / Owner for any proprietary or custom software and/or equipment prior to the beginning of the project.

E. All devices shall be installed with the manufacturer recommended mounts and accessories as necessary for the installation locations type as scheduled.

F. Unless otherwise stated, all software and licensing shall be for the most current, up to date version of the system provided. For existing systems, Contractor shall obtain written verification of the Owner's most current software version and notify via RFI the Architect / Design Consultant / Owner if implementation of the most current software / license version will require an upgrade to the Owner's existing system.

G. Architect / Design Consultant / Owner will have final determination of acceptability of all proposed equipment and must approve submitted equipment prior to purchase or installation.

H. Proposed equivalent items must be approved in writing by the Architect / Design Consultant / Owner prior to purchase or installation. Proposed equivalent items must meet or exceed these specifications and the specifications of the specified item.

I. In the event a manufacturer's specified product or part number has changed or is no longer available, Contractor shall submit a formal RFI for an appropriate substitute.

J. In the event of a discrepancy between the specifications and the drawings, the greater quantity and/or better quality will be furnished at no additional cost to the owner.

K. For listed products with no part number specified, Contractor shall provide a product that meets the performance requirements of these specifications, industry standard practices, and intended application.

L. Labels on all cabling, materials, and equipment must indicate a nationally recognized testing laboratory.

M. Contractor shall review all products specified and required for this project to determine if there are any lead times for any products that may cause any delay. Contractor shall clearly identify any concerns with lead times in writing to the Architect / Design Consultant / Owner. If the Contractor does not identify any concerns with products having long lead times, it will be understood there are no long lead time issues and the Contractor will have all products on-site when needed to complete the job as per the project schedule.

N. Any quantities listed are for reference only, contractor is responsible for furnishing materials as required to provide a fully functional turkey system. Where quantities are not noted, Contractor shall refer to drawings and schedules to determine exact quantities.

2.2 ACCEPTABLE MANUFACTURERS

A. Access Control System Manufacturers

1. Avigilon

B. Software

1. Avigilon - Software - ACM Enterprise (Listed as the basis of design)

a. Avigilon Control Center (ACC) and Access Control Manager (ACM)

C. Access Control Manager Licensing

1. ACM 16 Reader Count Software

a. AC-SW-LIC-16RCU-6-P

D. Hardware

1. Server

a. Existing (this shall be an extension of the County's existing system)

2. Controller (2-Door) – (Mercury Series 3 Boards - No Exceptions)

a. AC-MER-CONT-LP1502

3. Interface Modules – (Mercury Series 3 Boards - No Exceptions)

a. AC-MER-CON-MR52-S3B

4. Card Reader

a. Wall Mount
1) HID SIGNO 40
a) AC-HID-READER-SIGNO-40TKS-01-000000

5. Credentials
a. HID SEOS
1) Provide (100) Credentials to Owner

6. Door Contacts
a. Recessed
1) GRI 180-12
2) Or approved equal

E. Red VOIP Emergency Phone
1. Viking E-1600-IP-EWP
a. Contractor shall program phone to dial 911

F. Power Supplies (Dual Voltage, Network Managed)
1. LifeSaftey Power Prowire Mercury Series (Panduit wiring option)
a. FPO150/250-3D8P2M8NL4E8M1/P16-A
b. Or approved equal

2. Battery
a. Yuasa NP7-12
b. Or approved equal
1) For 12VDC – (1) Battery
2) For 24VDC – (2) Batteries in series

G. Security Cabling
1. 4 Element Access Control Cable
a. Windy City Wire 4461030 (4ELEMP-YLW)
b. Or approved equal

H. Data Cable
1. Reference Division 27 10 00 Structured Cabling System Specifications

I. Pathway Cable Support
1. Panduit J-Mod Cable Support System
2. Erico – CADDY CAT LINKS J-Hook Series
3. Panduit Plenum Rated Velcro Hook & loop (velcro) (Black)

J. Labeling
1. Permanent Labels for Copper Cables
2. Panduit Self-Laminating Labels
3. Or approved equal

K. Fire Stop / Sealants
1. STI Spec Seal
2. 3M Products

3. Masterseal NP1
4. Or approved equal

PART 3 - EXECUTION

3.1 CODES, STANDARDS, REGULATIONS

A. American National Standards Institute (ANSI)

B. American Society for Testing and Materials (ASTM)

1. ASTM B 1 (2001; R 2007) Standard Specification for Hard-Drawn Copper Wire
2. ASTM B 8 (2004) Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
3. ASTM D 1557 (2007) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
4. ASTM D 709 (2001; R 2007) Laminated Thermosetting Materials

C. Alliance for Telecommunications Industry Solutions (ATIS)

D. Building Industry Consulting Service International (BICSI)

1. Telecommunications Distribution Methods Manual 13th Edition
2. Outside Plant Design Reference Manual 5th Edition
3. ANSI/BICSI 002-2011, Data Center Design and Implementation Best Practices
4. NECA/BICSI 568-2006 – Standard for Installing Commercial Building Telecommunications Cabling
5. NECA/BICSI 607-2011, Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings

E. Federal Communications Commission (FCC)

1. FCC Part 15, Radiated Emissions Limits, revised 1998
2. FCC Part 68, Connection of Terminal Equipment to the Telephone Network, revised 1998
3. FCC Part 76, Cable Television Service, revised 1998

F. Homeland Security Presidential Directive 12 (HSPD12)

G. Insulated Cable Engineers Association (ICEA)

1. ICEA S-87-640 (2006) Fiber Optic Outside Plant Communications Cable
2. ICEA S-98-688 (2006) Broadband Twisted Pair, Telecommunications Cable Aircore, Polyolefin Insulated Copper Conductors
3. ICEA S-99-689 (2006) Broadband Twisted Pair Telecommunications Cable Filled, Polyolefin Insulated Copper Conductors

H. International Electrotechnical Commission (IEC)

I. Institute of Electrical and Electronics Engineers, Inc. (IEEE)

1. IEEE Standard 81-1983, IEEE Guide for Measuring Earth Resistance, Ground Impedance, and Earth Surface Potential of a Ground System
2. IEEE Standard 1100-1999, Recommended for practice for Powering and Grounding Sensitive
3. Electronic Equipment in Industrial and Commercial Power Systems (IEEE Emerald Book)
4. IEEE C2 (2007; Errata 2007; INT 2008) National Electrical Safety Code

5. IEEE Std 100 (2000) The Authoritative Dictionary of IEEE Standards Terms

J. International Organization for Standardization (ISO)

1. International Organization of Standardization/International Electrotechnical Commission (ISO/IEC)
2. ISO/IEC 11801, Information Technology-Generic Cabling for Customer Premises, 1995
3. ISO/IEC 14443-3:2011 – Identification Cards
4. ISO/IEC 14763-1, Information Technology-Implementation and Operation of Customer Premises Cabling-Administration, 1999

K. National Cable Television Association (NCTA)

L. National Electrical Contractors Association (NECA)

1. NECA 1-2015 Good Workmanship in Electrical Construction

M. National Electrical Manufacturers Association (NEMA)

1. NEMA C62.61 (1993) Gas Tube Surge Arresters on Wire Line Telephone Circuits

N. National Fire Protection Association (NFPA)

1. NFPA-70, National Electrical Code
2. NFPA-75, Protection of Electronic Computer Data Processing Equipment.
3. NFPA-101, Life Safety Code
4. NFPA-297, Guide on Principles and Practices for Telecommunications Systems
5. NFPA-780, Standard for the Installation of Lightning Protection Systems.

O. National Institute Standards and Technology (NIST)

P. Occupational Safety and Health Administration (OSHA)

Q. Security Industry Association (SIA)

R. Telecommunications Industry Association (TIA)

1. ANSI/TIA-568.0-D-1, Generic Telecommunications Cabling for Customer Premises.
2. ANSI/TIA-568.1-D, Commercial Building Telecommunications Cabling Standard.
3. ANSI/TIA -568.0-D.2, Balanced Twisted-Pair Telecommunications Cabling and Components Standard.
4. ANSI/TIA-568.3-D-1, Optical Fiber Cabling Components Standard.
5. ANSI/TIA–569-E Commercial Building Standard for Telecommunications Pathways and Spaces.
6. ANSI/TIA-606-C, Administration Standard for the Telecommunications Infrastructure.
7. ANSI/TIA-607-D, Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises.
8. ANSI/TIA-758-B, Customer-Owned Outside Plant Telecommunications Infrastructure Standard.

S. U.S. Department of Agriculture (USDA)

1. RUS 1755 Telecommunications Standards and Specifications for Materials, Equipment and Construction
2. RUS Bull 1751F-643 (2002) Underground Plant Design
3. RUS Bull 1751F-815 (1979) Electrical Protection of Outside Plant
4. RUS Bull 1753F-201 (1997) Acceptance Tests of Telecommunications Plant (PC-4)

5. RUS Bull 1753F-401 (1995) Splicing Copper and Fiber Optic Cables (PC-2)
6. RUS Bull 345-65 (1985) Shield Bonding Connectors (PE-65)
7. RUS Bull 345-72 (1985) Filled Splice Closures (PE-74)
8. RUS Bull 345-83 (1979; Rev Oct 1982) Gas Tube Surge Arrestors (PE-80)

T. Underwriters Laboratories, Inc. (UL)

1. UL 294 Standard for Access Control System Units
2. UL 294B Standard for Power Over Ethernet (PoE) Power Sources for Access Control Systems and Equipment
3. UL 109 Standard Method for Flame Tests of Flame-Resistant Fabrics and Films
4. UL 1076 Standard for Proprietary Burglar Alarm Units and Systems

3.2 EXECUTION - GENERAL REQUIREMENTS

A. Contractor shall comply with the requirements of local Authority Having Jurisdiction (AHJ), State of Texas, the National Fire Protection Association (NFPA), and the National Electrical Code (NEC). If the Contractor identifies any item in the plans or specifications that will not strictly comply with the aforementioned laws, ordinances, and rules, the matter shall be referred to the Architect / Design Consultant for direction before proceeding with that part of the work.

B. Contractor shall meet the specifications and standards from the latest NFPA and NEC publications. In the event of any conflicts between Standards and Codes the more stringent shall take precedence.

C. The Contractor shall install the materials in accordance with these specifications and the manufacturer's installation guidelines. Equipment and materials installed by the Contractor shall be free of defects and damage.

D. No deviations from the plans, details or specifications shall be made without full consent in writing of the Architect / Design Consultant. The Contractor shall have written approval from the Architect / Design Consultant for any additional work beyond the Contract Documents prior to beginning such work.

E. Prior to execution, Contractor shall verify no changes in software, licensing or hardware versions have occurred since the bidding of the project. In the event of any changes, Contractor shall verify system compatibilities with their proposed design, and notify via RFI the Architect / Design Consultant / Owner if the newest version(s) will require any upgrades / additional costs to the existing system(s).

F. In the event site conditions do not allow the contractor to follow the execution requirements specified herein or in the provided details, the Contractor shall submit via RFI an alternative means and methods that is approved in writing by the Architect / Design Consultant.

G. The Contractor shall obtain written permission from the Architect / Design Consultant before proceeding with any work that would necessitate cutting into or through any part of the building structure such as, but not limited to: girders, beams, floors, walls, roofs, and/or ceilings.

H. If the Contractor does not obtain written approval from the Architect / Design Consultant prior to proceeding with the work, the contractor shall not be reimbursed for the work.

I. Contractor shall notify the Architect / Design Consultant a minimum of (2) weeks prior to beginning work and will participate in a pre-construction meeting with the Architect / Design Consultant to perform a walkthrough, review the scope of work, schedule, and escalation procedures.

J. The Contractor shall maintain a work area free of debris, trash, empty cable reels, scrap cable, etc., and dispose of such items on a daily basis and return the site to the original

state of cleanliness. The Contractor shall not use Owner's facilities for the disposal of excess or scrap materials.

K. Contractor shall be responsible for the repair of any damage caused by the contractor during the installation.

L. Contractor shall test all cables prior to and post installation. By failing to perform this testing operation, the Contractor shall accept the cable as compliant and assume all liability for the replacement of the cable at no cost to the Owner should it be found defective at a later date.

M. Contractor shall maintain a set of working specifications, design drawings, and record drawings to be kept on site at all times and shall update the record drawings with any changes on a weekly basis. Record drawings shall be made available for inspection at the request of the Architect / Design Consultant.

N. Equipment and materials shall be consistent throughout the installation. Where multiple units of the same type of equipment and materials are required, these units shall be a standard product with the same manufacturer and model number.

O. Equipment and materials shall be delivered and stored in accordance with the manufacturer's guidelines at the Contractor's expense.

P. Contractor shall make all stored equipment and materials available for inspection at the request of the Architect / Design Consultant.

Q. All equipment and material used in the installation shall be approved by the manufacturer for the environment in which it is being installed.

R. All devices shall be installed flush, plumb, and (where required) centered on the wall, ceiling tile or structure for which it is being installed, unless otherwise noted.

S. Devices installed in public spaces shall be mounted and secured using tamper-proof security fasteners unless otherwise noted.

T. Cables shall be properly supported in accordance with industry standards at all times. Improperly supported cables shall be corrected by the Contractor at no cost to the Owner.

U. Contractor shall be responsible to properly protect information outlets from damage by other trades during construction.

V. Cables shall be routed at 90-degree angles to the building structure. At no time shall a diagonal pull be installed.

W. The Contractor shall not install cables in conduits or sleeves without nylon bushings. Cables installed through conduits or sleeves without nylon bushings shall be removed and replaced at no cost to the Owner.

X. The manufacturer and contractor shall take positive measures to prevent the introduction of cybersecurity threats to the Owners technology infrastructure. These measures shall include but are not limited to:

1. The contractor shall scan contractor owned equipment for cyber threats such as viruses, malware, ransomware, etc., prior to connecting the contractor owned devices to the Owners network.

2. Ensure all technicians installing or configuring equipment are trained on the prevention of introduction of cyber threats to electronics, i.e. servers, and other associated equipment.

3. All project documents shall be properly securely stored behind encryption and password protection to avoid unauthorized distribution of documents.

Y. Labeled Doors and Frames

1. In no instance shall any UL labeled door or frame be drilled, cut, penetrated, or modified in any way.

2. The Contractor shall be responsible for replacing any labeled door or frame that is modified without written approval from the Architect.

3.3 COORDINATION REQUIREMENTS

A. The Contractor is responsible for the coordination of the following items and their respective disciplines included but not limited to.

B. Coordinate with the Architect to ensure that:

1. Adequate conduit is provided and that equipment backboxes are adequate for system installation.

2. Adequate power has been provided and properly located for the security system equipment.

3. Doors and door frames are properly prepared for electric locking hardware and door position switches.

4. Access hatch locations (when required) shall be submitted in writing via RFI and coordinated with the Architect.

5. Finishes and colors of all equipment visibly installed in public areas. Submit all finish and graphics for all equipment to the Architect for approval prior to installation.

C. Coordinate with the Division 8 contractor for the following:

1. Door hardware manufacturer installation and power requirements.

2. Installation, power and requirements for integral request to exit switches.

D. Contractor is responsible for coordinating with gate controller installers for controller locations and interfacing terminations.

E. Coordinate with the Division 14 (Elevators) contractor for the following:

1. Pathways, installation, cabling, power requirements, media converter, and enclosures within the elevators shaft, wall, and/or elevator control room.

2. Security device cable pathways and terminations to be done by elevator contractor or under direct supervision of elevator contractor.

3. Any drilling or mounting in cab shall be performed by the Elevator Contractor. Security Contractor shall provide all security device mounting/drilling templates to the Elevator Contractor.

4. Interfacing of elevator controls to the Access Control system

a. Software integration is preferred

b. Coordinate with ACS manufacturer for compatibility and licensing requirements

c. If no other method is possible, contractor shall interface via relay cabling from the Access Control System to the designated elevator security interface.

1) Ensure adequate relay signaling cabling is provided for interfacing of each floor

F. Coordinate with the Division 26 contractor for the following:

1. Power requirements, conduit sizes/pathways, sleeves, back boxes, grounding, and bonding requirements of security devices in the following locations:

a. Interior of the building

b. Exterior of the building

c. Pole, pedestals, canopies, awnings, building architectural surface, etc.

d. Special conditions (clean room, hazardous areas, roof top mounted devices, etc).

2. Coordinate location and termination of earth ground for all device specified herein as required per manufacturer installation requirements.

G. Coordinate with the Division 27 contractor for the following:

1. Installation and power requirements of network infrastructure associated to the specified system
2. Associated patch cable lengths and quantities required for the specified system.
3. Location, power, and backup requirements for rack mount equipment.

H. Coordinate with the Division 28 (Fire) contractor for the following:

1. Door hardware manufacturer installation and power requirements associated with fire alarm system(s).
2. Door hardware manufacturer installation and power requirements for all ACS electric locking mechanisms with time-delay ("delayed egress") functions as defined by NFPA 101.

I. The Contractor is responsible for coordinating ACS locations and mounting preferences of all specified security devices with the Architect / Design Consultant prior to installation.

J. The Contractor is responsible for coordinating all ACS programming requirements with the Owner / Architect / Design Consultant.

K. The Contractor shall coordinate with the Owner for the following:

1. Network IP addressing for networked system equipment, controllers, and devices
2. Device labeling scheme
3. Firmware/software updates
4. Client workstations requirements and locations
5. Location of rack mount equipment.
6. Locations, type, programming, configuration, and Owner's final expectations for any Contractor Furnished Contractor Installed (CFCI) equipment and devices.
7. Uninterruptible Power Supply (UPS) requirements.
8. Painting of exposed, publicly visible conduit pathways
9. Credential reader card formats, LED, buzzer and associated visual/audio functionalities.
10. When required, credential card ordering, formats, facility codes, barcode and template requirements or standards prior to install. Coordinate timelines for delivery and distribution of the credentials to the Owner prior to procurement.

3.4 SYSTEM REQUIREMENTS

A. General

1. The Access Control System (ACS) shall consist of server(s), software, licensing, workstations, doors controllers, access control cabling, credentials and all other peripheral components as indicated on the drawing and specified herein.
2. Any devices associated with the installation shall have the latest firmware updates downloads via owner approved secure link from the system software and/or remotely from the manufacturer.
3. All Access Control software, equipment and system requirements shall be installed per their respective Manufacturer Installation Guidelines.
4. Programming and data entry to be provide by the Contractor. Contractor shall program the Access Control System to provide the following basic functions included but not limited to:

a. Database Importing (Active Directory, CSV file, etc.)

b. Graphics Maps

c. Time zones

d. System Reports

e. Threat / Emergency Management Protocols (Lockdown, Severe Weather, etc.)

f. Role Based User System Access (Admin, User Privileges, etc.)

g. Access levels (Areas, Floor Groups, User Groups, etc.)

h. Schedules (Lock/Unlock, Auto Arm/Disarm, etc.)

i. Auxiliary I/O Devices (Sirens, Strobes, Buzzers etc.)

j. Door Configuration Settings to include but not limited to:

1) Anti-Pass Back

2) Door Release via Push Button Input

3) Door Release via Request to Exit (Maglock ONLY)

4) Door Forced / Door Held Alarms Conditions

5) ADA Door Settings

k. Special Conditions (Fire Alarm Relays, Hold Opens, Elevators, Gate / Door Operators, etc.)

5. When programming and data entry for the system is to be completed by Owner, Contractor is responsible for initial programming to ensure the installed field devices, media converters, etc., are communicating to the head-end equipment, so that the Owner can complete the necessary programming and shall assist in troubleshooting in the event they do not.

B. Access Control System (ACS) Software

1. Application / Client Workstation Software

a. The ACS software shall be installed as the most current version; contractor shall coordinate with owner prior to the upgrade/install to identify and evaluate any software conflicts. Conflicts shall be brought to the attention of the design team prior to bidding via Request for Information (RFI). Contractor shall coordinate the install and configure software on workstation(s) as required to provide a full turnkey ACS system.

C. Access Control System Licensing

1. Contractor shall be responsible for providing and applying all necessary licensing key(s) for the specified system(s) as required by the manufacturer(s) for a fully functioning access control system.

2. Contractor shall maintain a secured document with all license key(s) information applicable to this project. All license key(s) are property of the owner and shall be kept secured at all times and then surrendered to the Owner at the end of the project.

D. Access Control System Hardware

1. ACS Server

a. The video server shall be Virtualized / Cloud / Stand-alone installed in centralized data center / MDF

b. The access control file servers shall meet or exceed the ACS manufacturers requirements for the size and complexity of the access control system being installed.

c. Contractor shall coordinate with Owner for server mounting location and additional requirements.

d. Contractor shall coordinate with the Owner / Architect / Design Consultant for any updates or changes to the submitted equipment as a result of changes technologies or updated requirements prior to installation

2. Communications

a. Communication between servers, and workstations, networked based controllers/sub-controllers will communicate using the Owner provided data network unless otherwise noted. Coordinate with owner for network configuration requirements.

b. The ACS shall also support end to end 128-bit encryption unless otherwise noted.

c. Alternative communications means and methods shall be provided by Division 28 where applicable.

E. Access Control Workstations

1. Operator/Client Workstation

a. The Operator/Client Workstation shall be Owner-Furnished, Owner-Installed

b. The Contractor-provided Operator Workstation shall consist of the workstation and peripherals included but not limited to:

1) System Workstation

2) USB Mouse and Keyboard

3) One Large Screen Monitor as specified

c. All system workstations shall run on an ACS manufacturer recommended operating system platform.

d. All operator interfaces with the system shall be through system workstations and shall display real-time system messages, data files and records, operator instructions, data programming information and custom graphic illustrations.

e. A system workstation keyboard and mouse shall provide for entry of operator commands and acknowledgments, and system database queries.

f. System workstations shall not be proprietary to the Contractor. The Owner shall be able to purchase additional system workstations from computer vendors other than the Contractor.

2. ID Badge Printing Workstation

a. The ID Badge printing Workstation shall be Owner-Furnished, Owner-Installed

b. The Contractor-provided Badging Workstation shall consist of the workstation and peripherals included but not limited to:

1) System Compatible Camera with Tripod

2) System Compatible Badge Printer

3) Back Drop with Stand (Coordinate Color with Owner)

4) Credential Cards (QTY TBD) – as specified in Part 2

5) Printing Supplies relative to above card quantity noted above

6) Cleaning Supplies

7) Associated Cabling

8) 20 inch "Vanity" Monitor

9) Slot Punch as required

10) Badge Holders & Lanyards as required

c. Coordinate with Owner for installation locations of workstation and associated peripherals prior to install.

d. Ensure software is capable of third-party interfaces of auxiliary database systems (Kronos, Active Directory, etc.). Contractor shall furnish and install the necessary software plug-ins to print the referenced information on the credential cards as required.

e. Ensure all badge templates and barcode fonts are loaded into the badging workstation to perform a test print of sample credentials cards as required. Coordinate with the owner and manufacturer for badge template design and font barcode requirements.

3. Access Control System Controller(s)

a. Install Controller(s) in designated MDF/IDF room(s) as indicated on drawings

1) The Controller(s) shall be wall mounted in the ACS manufacturer's UL listed enclosure, unless a separate manufacturer enclosed power supply solution is specified that is specifically designed for the controller board(s) specified herein. The enclosure shall consist of the following

a) Single cover, hinged, with identical key cylinder lock(s) for all enclosure(s). Hinged double doors will not be accepted.

b) Contractor shall furnish, install, and connect tamper switch for all enclosure(s) to the controller(s) as specified. One alarm input is needed per MDF/IDF to alarm via the ACS system when the enclosure is opened.

c) Contractor shall furnish, install, and connect Battery Fail/Power Loss alarm inputs to the controller(s) as specified. One alarm input is needed per MDF/IDF to alarm via the ACS system in the event of low battery/power loss conditions.

d) Enclosure(s) shall be mounted flush, plumb, and properly secured on fire-rated plywood using appropriate mounting hardware. Pathways to or from the enclosure(s) shall mechanically protected in a conduit or gutter system. Exposed cabling is not permitted.

b. Device power shall be provided from a UL listed power supply or PoE powered network switch where required in accordance with the manufacturer's requirements.

c. Controller(s) shall be installed per the construction documents.

d. Controller(s) shall be installed and configured in accordance with the most current manufacturer installation instructions.

e. The installation shall be performed or directly supervised by a manufacturer-certified technician.

1) The term "supervised" means the certified technician shall be on-site and supervising the installation.

2) The certified (on-site) technician shall have a copy of the manufacturer certification on-site readily available for review.

3) The manufacturer certification shall be current and valid.

f. Provide one spare card reader input point and 20 percent spare alarm input points and output point's after all specified points are initially connected. Sufficient modules shall be provided to accommodate only the number of card readers initially installed, as well as one spare input per control panel at each communications closet or consolidation point.

F. Access Control System Credential Readers (Cards, Vehicle Tags, PIN, Biometric)

1. Provide credential reader(s) as indicated on the drawings.
2. Readers shall be securely mounted flush and plumb on the wall/mullion per the manufacturer installation guidelines.
3. Exterior credential readers shall be installed with a weather-proof gasket as recommended by the manufacturer.
4. Exterior credential readers mounted on gates or vehicle pedestals shall be securely mounted in a NEMA rated weather-proof enclosure.
5. Where a weather-proof gasket is not sufficient for weather-proof protection, a polyurethane sealant for exterior use shall be applied.
6. Readers shall be installed with the manufacturer provided tamper-proof security fasteners, unless otherwise approved in writing by Architect / Design Consultant. If tamper-proof security fasteners are not provided, the contractor is responsible for procuring the requested hardware at no cost to the owner.

G. Access Control System Credentials (Cards, Vehicle Tags, PIN, Biometric)

1. All credential cards shall be surrendered to the owner in their original packaging after procurement.
2. Template / Card Format / PIN numbers
   a. Security Contractor shall coordinate PIN number assignment with the Owner prior to any programming.
   b. Security Contractor shall maintain a digital record of all Template / Card Format / PIN numbers to be secured at all times, and then provide to Owner at Project Close-Out.
3. Unless otherwise directed, the contractor is responsible for the mounting of vehicle tags. Contractor shall confirm with the Owner the placement of interior / exterior vehicle tags in writing.

H. Door Position Sensors (Door Contacts, Tamper Switches)

1. Provide magnetic concealed door position switches, surface mount door position switches and overhead door position switches to monitor the open/closed status of doors as specified herein and as indicated on the drawings.
2. The contractor shall ensure the circuit of the door position sensor shall match the physical status of the door opening i.e. Normally Closed when the door is closed.
3. Exterior mounted door position sensors shall terminate using the appropriate outdoor-rated weatherproof connections and fasteners based on site conditions.
4. Provide flexible metallic conduit (as required) from the sensor location to the associated junction box as indicated on the drawings. Conduit shall be securely fastened to the structure using proper fasteners based on site conditions.
5. Contractor must ensure adequate spacing between contact and magnets to avoid abrasion / damage to the device.
6. Install end of line resistors for line supervision. Refer to manufacturer for recommended resistance values
7. Tamper shall be mounted inside the enclosure on key switch side.

I. Request-to-Exit

1. For doors equipped with electric locking mechanical that are free exiting at all times (i.e. mortise electric locks, electric strikes, etc.), the REX motion sensor shall only shunt the door position sensor from the Access Control System unless otherwise noted.

a. Integrated in Electrified Door Hardware

1) Security Contractor shall route cable from door controller to access controlled door as indicated on the drawings and terminate the specified cable to the top of the Division 8 installed Electrified Power Transfer Hinge.

a) At the time of installation of the door hardware, The Security Contractor shall provide and install all end of line resistors required by the PACS System Manufacturer.

b) Security Contractor shall not remove Division 8 Installed Door Hardware unless otherwise approved in writing by the Architect / Design Consultant.

b. Request-to-Exit Motion Sensor

1) Motion sensor shall be mounted flush, plumb, and properly secured on a single gang box or mechanical brace using appropriate mounting hardware and trim plate.

2) Motion sensors shall be positioned close to the door opening and angled to prevent tampering from forced entry. Contractor shall ensure devices mounted in the ceiling space are not obstructed or impacted when servicing in relation to other ceiling mounted devices (Exit signs, smoke detectors, lighting fixtures, etc.)

J. Door Release / Duress / Lockdown

1. Provide desk-mounted or wall mounted personnel duress alarms with normally closed alarm output contacts as indicated on the drawings.

2. Door Release / Duress buttons / Lockdown shall be wired to the Access Control System input boards as scheduled.

a. The Door Release / Duress / Lockdown button shall be mounted flush, plumb, and properly secured as scheduled.

1) The Door Release button shall be configured as momentary.

2) The Duress button shall be configured as latching.

a) Latching keys to be turned over to the Owner via the Construction Manager.

3) The Lockdown button shall be configured as latching.

b. Security device cabling installed in the knee space shall be mechanically protected with an armored flex from the rough-in back box to the edge device as scheduled. No exposed cabling is permitted.

K. Card Reader Wiegand Signal Extender

1. Provide card reader Wiegand signal extension devices as necessary for card readers with cable distances to the DGP greater than 498 feet as required.

2. Provide power and associated cable as recommended by manufacturers

L. Access Control Intercom Systems

1. Unless otherwise stated, all intercom configurations shall be Contractor Programmed.

2. Intercom shall be configured to dial to the associated handset unless otherwise stated.

3. Door Release via the PACS shall be initiated through programming and relay cabling from the intercom / intercom master station to the associated door relay board.

4. Coordinate audio recording requirements from intercom systems

M. Electrified Door Hardware Mechanical Connections (Division 8)

1. Contractor shall conceal security cabling in door frame, door channels, walls wherever possible. Submit RFI if site conditions do not allow and propose alternative methods of terminations.
2. The Division 28 Contractor shall not make any modifications to fire rated doors without obtaining written permission from the Architect.
3. The Division 28 Contractor is responsible for providing the following:
    a. Provide relay signal cabling only from the ACS to the Division 8 power supply or relay board(s) located either at the door or centralized location
    b. Termination of Lock Relay Power for PoE based networked door controllers up to the electrified door hardware
    c. Device power provided by Owner-provided PoE networked switch.
4. The Division 8 Contractor is responsible for providing the following:
    a. Final terminations of all internal wiring of electrified door hardware and door power supply connections.
    b. Final terminations from the door power supply or relay board up the power transfer hinge or similar connection point of the electrified door hardware.

N. Elevator Interface Requirements

1. The Contractor shall review the drawings and specifications and confirm all required cabling within the elevator travel cable is present for security peripherals shown on the security drawings. Any additional material included but not limited to: media converters, power injectors, power supplies, transformers, relay cabling or direct/indirect labor shall be furnished and installed by the Contractor to facilitate operation.
2. The Contractor shall furnish and install an elevator security interface as shown on plan drawings. The Interface shall include all provisions to support alarm monitoring and authorize access to select floors.
3. The Contractor shall furnish and install all security peripherals within the elevator systems or cab. All work within the elevator control room, elevator shaft, and elevator cab shall be coordinated with the Elevator Contractor. Only the Elevator Contractor shall alter, install, or make modifications to the elevator return panel, interior finished areas within the elevator cab, equipment in the elevator control room. Elevator control equipment and any required programming of the elevator system and wiring from the card readers and/or IP PoE cameras in the elevator cab and at the elevator lobbies to the elevator machine room will be provided by the Elevator Contractor.
4. The Contractor shall be responsible for extending cabling for security peripherals devices and relays from the elevator security interface to the elevator equipment interface for final connection by the Elevator Contractor. A redirect panel shall be provided by the Contractor, in the elevator machine room. Contractor shall furnish and install and midpoint break out boxes between the security elevator interface and elevator equipment interface as required. The breakout box shall be alarmed with tamper and key lockable.
5. Programing of the security elevator interface relays and card readers shall be led by the Owner with assistance from the Contractor as required

O. Access Control System Power Supplies

1. Unless otherwise noted, all power supplies shall be hardwired to the 120VAC circuit. No pigtails / plugs shall be acceptable.
2. Enclosed Wall Mounted Access Control Panel Power Supply

a. The Security Contractor shall provide and install devices as indicated on the drawings.

b. Security Contractor shall refer to Division 8 Finish Hardware schedules and system requirements for sizing and quantity of boards in the enclosed power supply.

c. The Security contractor shall provide dual voltage power supply board as specified.

d. The Security Contractor shall provide and install Power Control Modules as specified.

1) Each Lock power output cable shall be terminated to a dedicated port on the Power Distribution Module specified.

e. The Security Contractor shall provide and install Power Distribution Modules as specified.

1) Each request-to-exit motion (where required) cable shall be terminated on a dedicated port on the Power Distribution Module.

f. The Security Contractor shall size each enclosure(s) with dual voltage power supplies as specified to include an additional total amperage of at least for 20% additional maximum amperage output per enclosure for future expansion as required.

g. The Security contractor shall provide (2) back up batteries as specified per each enclosure.

h. 115VAC hardwired power shall be provided and installed by Division 26 Electrical Contractor.

i. 30Amp dedicated circuit shall be provided and installed by the Division 26 Electrical Contractor.

j. Provide U.L. Listed power supplies for all Access Control System panels as specified.

k. Provide battery chargers and batteries for all power.

l. Monitor low battery and power fail alarms for each power supply.

m. Tampers shall be wired as recommended by the manufacturer.

3. Backup Battery(s)

a. The Security Contractor shall provide and install (2) batteries per power supply enclosure.

b. The Security Contractor shall label the install date for each battery with printed labels.

P. Door Management and Local Alarm Units

1. Provide unit for local and remote monitoring of the secure status of doors as indicated on the Security Drawings.

2. The units shall provide for supervised monitoring of the door position switch(es) for the associated door(s). Functions are listed as follows including but not limited to:

a. A horn within the unit shall sound and a normally closed alarm output contact from the unit shall be activated whenever a protected door is held open beyond a user adjustable time (0 to 60 seconds). Adjust the timer to zero so that the unit activates immediately when a door is opened. At the option of the Owner, certain unit's may be configured to allow the door(s) to be opened for a selectable period of time (0 to 60 seconds) without generating an alarm.

b. An integral keyswitch shall provide for activation of an authorized bypass timer, which shall allow the door to be opened for up to 15 seconds without initiating an alarm condition. The key cylinder shall be provided by the door hardware

supplier and shall be keyed to the Owner's master key system. Coordinate with the Architect as required to ensure proper keying of all units.

3. Provide remote bypass key switches as indicated on the Security Drawings (as applicable) for activation of the authorized bypass timer from the side of the door opposite the unit. The remote key switch shall provide the same functions as the integral key switch. The key cylinder shall be provided by the door hardware supplier and shall be keyed to the Owner's master key system.
4. The LA shall have a user selectable automatic reset that shall reset the horn and alarm output contact up to one minute after activation of the alarm.
5. Provide for remote reset and deactivation the unit through control output contacts activated manually by the ACS File Server / system workstation keyboard and ACS time schedule.
6. The unit shall have a tamper switch that shall immediately activate the output alarm contact upon removal of the unit from the wall.

Q. Access Control Cabling

1. Pathways
   a. Wires shall be routed utilizing the pathways as indicated in the technology drawings. Reference Division 27 specifications for additional requirements.
   b. Access control cabling shall be routed separate from the network data communication cables specified in Division 27. Contractor shall provide separate pathways and j-hooks for the cables specified herein.
2. Wiring Techniques
   a. All cables shall be pre-tested for shorts prior to final device terminations after cables are installed.
   b. The Contractor shall install a 10-foot service loop to be coiled, mounted, and stored in the provided enclosure(s) as detailed in the drawings. If an enclosure is not provided for the specified devices herein, the service loop shall be installed on a j-hook in the nearest accessible ceiling space closest to the device.
   c. The Contractor shall install a 10-foot service loop to be coiled, mounted, and stored at the access control panel.
   d. The Contractor shall install a 10-foot service loop to be coiled, mounted, and stored on the wall above the ladder rack in the regional MDF / IDF room(s).
   e. Install code compliant fire proofing techniques for all penetrations of fire rated partitions and slabs, where the penetrations are made by or used for installation of the ACS.
   f. All wire and cable shall be continuous from device location to the final point of termination ("Home Run"). No mid-run cable splices shall be allowed.
   g. Wire and cable within control panels, power distribution cabinets and other security enclosures shall be neatly installed, completely terminated, pulled tight with slack removed and routed in such a way as to allow direct, unimpeded access to the equipment within the enclosure. All wire and cable shall be bundled and tied. Velcro cable ties shall be utilized.
   h. Neatly bundle and wrap all horizontal / vertical runs (above accessible ceilings and not within conduit) wire and cable at intervals as code requires. Provide supports as required. All supports shall be UL listed for the application.
   i. All system wiring within vertical riser shafts (as required) shall be bundled, wrapped and tied to the structure at one-meter intervals in order to isolate it from other wire and cable within the shaft. Additionally, all wire and cable within the shaft shall be supported at least every two floors using manufacturer approved vertical management hardware and installation methods. Provide all

personnel and equipment necessary to install and support the cable. All equipment shall be UL listed for the application.

j. Provide grommets and strain relief material where necessary to avoid abrasion of wire and excess tension on wire and cable.

3. Splices / Transitions

a. Home run cabling is the preferred method of installation for all Access Control System devices and panels.

b. In the unlikely event that a splice or transition is required, the Contractor shall identify all splices / transition points required for the completion of the project and confirm, in writing, in advance, via RFI with the Architect / Design Consultant for acceptance of the proposed wiring techniques to be utilized.

c. By not submitting an RFI, Contractor acknowledges that no major splicing is required for the completion of this project. Any splices not previously identified that are found to be faulty shall require the Contractor to re-install the affected cable in its entirety at no cost to the Owner.

d. Contractor shall clearly mark splices / transition points on the shop drawings and As-Built drawings as part of the project close-out.

4. Cable Dressing

a. No excessive cable slack shall be left in enclosures.

b. Cables shall be dressed in a professional manor

c. Cables shall be routed in 90-degree angles to termination points inside enclosures.

d. Ty raps / zip ties are not permitted, hook and loop / Velcro is acceptable.

e. Exposed wires are not acceptable

f. Enclosures and equipment / Telecommunication room shall be left clean without debris including but not limited to: labels, connectors, screws, etc.

g. All spare / unused cables shall be in the enclosure shall be neatly coiled and protected to avoid any shorts to ground.

R. Device Labeling

1. Unless otherwise, all installed devices shall be labeled. Contractor shall verify device numbering scheme and Owner's current naming convention standard in writing in advance via RFI prior to generating any labels.

2. All labels shall be machine printed and adhered to the device in a location that is visible and legible to the naked eye.

3. All labeling in the field shall match the same labeling scheme in the closeout documents.

4. Refer to Div. 27 specifications for data network device cabling requirements.

5. Cables overall sheath shall be labeled within (6) inches from the point the cable enters/exits the enclosure inside the Equipment Room / Telecommunications / Security Control Location Rooms.

6. Cables shall be labeled within (1) inch from the termination point inside the Equipment Room / Telecommunications / Security Control Location Rooms.

7. Cables shall be labeled within (1) inch from the termination point at the device end.

8. Cables shall be labeled identically at both ends.

S. Fire Stop / Smoke / Sound Sealants

1. Use proper sealant as recommended by the manufacturer for the specific application in compliance with per all applicable codes: City, State, Federal, LAHJ.
2. All existing pathways shall be resealed in compliance with per all applicable codes: City, State, Federal, LAHJ.

T. Grounding and Bonding

1. All grounding and bonding shall be performed by a licensed electrical contractor to ensure the electrical integrity of the low voltage system and devices specified herein per federal / state / local codes and standards.
2. Contractor shall notify the Architect / Owner / Design Consultant via written RFI of any site conditions or installations that will require additional coordination.
3. Contractor shall ensure proper grounding of shielded or non-shielded cabling and devices conform to the specified devices manufacturer's installation guidelines.
4. The Division 28 Contractor is responsible for coordinating with the Division 26 Contractor for grounding and bonding security devices per applicable codes and standards.

U. Conduit, Boxes and Raceways (For Reference Only - By Division 26)

1. Install all conduit necessary for a complete installation, but not provided for in the Security Drawings, in finished areas concealed in chases, furring's, concrete slabs and/or above suspended ceilings. No exposed conduit shall be installed within public areas.
2. Conduit shall be carefully installed, properly and adequately supported as required to comply with the requirements outlined herein and as required by the NEC to provide a neat, industry-standard installation. Horizontal conduit runs shall be supported by clamps, pipe straps, special brackets or heavy iron tie, tied to the black iron structural members supporting the ceiling. Fastening of conduit to masonry walls, floor or partitions require malleable pipe clips with screws and suitable expansion sleeves.
3. All conduit shall be cut accurately to measurements established at the building and shall be installed without springing or forcing.
4. All required inserts shall be drilled-in and all openings required through concrete or masonry shall be saw cut or core drilled with tools specifically designed for this purpose.
5. Swab out and remove all burrs from conduit before any wires are pulled.
6. Lay out and install conduit runs as to avoid proximity to hot pipes. In no case shall a conduit be run within 75 mm of such pipes, except where crossings are unavoidable and then the conduit shall be kept at least 25 mm from the covering of the pipe crossed.
7. Provide fire stops where conduits penetrate fire rated walls and/or floors.
8. All conduit installation, whether run exposed or concealed, shall be approved prior to installation by the Architect.

V. High Voltage (120VAC) Power Requirements (For Reference Only – by Division 26)

1. 120VAC AC power dedicated to security shall be provided by the electrical contractor for the Access control system as indicated on drawings. Coordinate with the Architect to establish locations of security dedicated 120VAC AC circuits.
2. Connect to the AC power (provided by electrical contractor) and provide UL listed power supplies and transformers to distribute low voltage power to the system components as required.
3. Provide all conduit and wiring from the AC power facilities to the Access Control / Power Supply Enclosures.

4. Provide Mechanical separation to isolate 120VAC wires from other low voltage cabling. Low voltage cabling shall not route over/under/parallel to 120VAC wires.

W. Surge Protection / Lightning Arrestors

1. Protect all exterior devices, control, power, signal cables and conductors that are power surges. Each surge protector shall be UL Listed.
2. Unless otherwise noted, surge protection devices shall be installed at both the edge and head end of the cabling run.
3. Surge devices shall be installed as close as accessibly possible to the equipment they are protecting.
4. Surge Protection shall be properly installed in an accessible ceiling or enclosure space to allow for cable removal during troubleshooting.
5. Include surge protection device locations on as-builts and shop drawings.
6. Provide protection against spikes, surges, noise, and other line problems for all system equipment and components.
7. Properly ground surge protection devices per the manufacturer installation requirements.

3.5 TESTING REQUIREMENTS

A. As a prerequisite, the Contractor shall perform a burn-in of the system that is in accordance with the manufacturer's installation guidelines.

1. All devices shall be powered up and tested in a phased approach in a controlled testing environment on or off premise (to be coordinated with the Owner).
2. Update firmware with most up to date version (to be coordinated with the Owner).

B. Each system hardware device shall remain operational during the burn-in test for a minimum of eight (8) hours without failure.

1. Contractor shall provide successful burn-in results in writing to the Architect / Design Consultant prior to final acceptance.

C. Security Contractor shall conduct a complete QA/QC test of the entire system and provide a written report of the test results (Punchlist). The tests shall include, but not limited to:

1. Hardware
2. Software
3. Network Connectivity
4. Device Power
5. Configure system device settings

D. Identify and remediate any issues and/or system faults

E. It is the responsibility of the Contractor to verify that all devices, equipment, software, interfaces, sub-system interfaces and integrations are fully functional and operational.

F. Contractor shall rectify all issues discovered during the QA/QC process and shall document these corrections via a Contractor provided punch-list.

1. At a minimum the punch-list shall contain:
   a. Date of the item identified
   b. Description of the discrepancy with photographs as necessary.
   c. Date the item was rectified

G. All QA/QC items shall be corrected, and an electronic report surrendered to the Architect / Design Consultant prior to calling for Substantial Completion.

3.6 TRAINING REQUIREMENTS

A. Provide for (8) hours of training for five (5) persons on each system.

B. Provide a test report showing the system has been 100% tested and 100% operational prior to training / demonstration.

C. Coordinate with the Owner to establish a training outline and schedule. Submit a comprehensive training curriculum to the Owner once all preliminary coordination is complete. The Owner will revise and comment on the curriculum as required.

D. Contractor training shall be conducted onsite/virtually with a manufacturer's representative in attendance.

E. Operator training shall include, but not be limited to the following:

1. All operating procedures and graphic user interface (GUI)
2. System configuration
3. Alarm acknowledgement, alarm response logging, and map graphics functionality
4. Image capture, badge printing, and print ribbon replacement.

F. Administrative training shall include, but not be limited to the following:

1. All operating system procedures, configuration variables and graphic user interface (GUI)
2. Database functions and setup
3. Cardholder input and deletion procedures
4. Report generation
5. Card format configuration
6. Badge creation and design

G. Record, label, and catalog all training on DVD and "user's manual" written specifically for the Owner personnel onsite, for daily routine operations of the systems. Provide the DVD and user's manual to the Owner for future in-house training sessions and / or reviews. Furnish all temporary equipment necessary for recording all training sessions. Maintain accurate and up-to-date time sheets of all training sessions.

H. The Owner reserves the right to use any excess training hours, not used by the time of system completion, for future training as requested until the total number of training hours has been completed.

3.7 FIELD OBSERVATIONS

A. A minimum of ten business days in advance, Contractor shall notify the Design Consultant and Owner as to the readiness for a Field Observation for the following at a minimum but not limited to:

1. Rough-In Observation – after conduits have been installed, but before walls have been installed.
2. Above Ceiling Observation – after cabling has been installed, but before ceilings have been installed.
3. Final Site Observation – a minimum of two weeks before Substantial Completion.

B. During Design Consultant's Final Site Observation of the installed systems, provide a minimum of one factory-trained/certified technician on the operation of all installed systems for up to (1) 8-hour day to assist with Design Consultant's functional testing.

C. Non-Conforming Work (Punch-List)

1. After receipt of written notice of deficiencies (Punch-List), Contractor shall correct all defective work within ten business days. If the work has been identified to be corrected by the Architect/Design Consultant, the Contractor shall remediate it in conformance with the contract documents at no cost to the Owner.

3.8 SUBSTANTIAL COMPLETION

A. It is the responsibility of the Contractor to ensure that all punch list items are 100% complete. The Contractor shall complete an internal Quality Assurance / Quality Control inspection, make all corrections, document the deficiencies and corrections prior to requesting for any further inspections with the Architect / Owner / Design Consultant.

B. Prior to any Substantial Completion, the Contractor shall submit a minimum two sets of preliminary (first draft) Record Drawings (As-Builts) to the Architect/Design Consultant. The preliminary Record Drawings are to be used by the Architect/Design Consultant to conduct the system substantial completion inspection.

C. The Contractor shall notify the General Contractor / Architect / Design Consultant that all the items noted above have been completed and the installation is ready for inspection.

D. The Architect / Design Consultant shall schedule an inspection of the installation with the General Contractor and the Installing Contractor(s) present.

E. The Substantial Completion Inspection shall consist of the following:

1. The Project Manager/Superintendent and Installation Technician shall be on site with all tools, materials, and equipment ready to resolve any minor issues identified.

2. The Design Consultant or designated representative shall visually inspect the installation in accordance with the official design documents.

a. The Contractor shall be prepared to remove and reinstall (minimum 10%) randomly selected security devices to inspect the mounting, cabling, terminations, connectors, labeling, tampers.

3. Punch list items shall be identified and documented in a provided punch list with a date and description of the issue found, and a date the discrepancy was addressed and the resolution.

F. Provide all personnel, equipment, and supplies necessary to perform all site testing. All video surveillance cameras shall be pointed and aimed in the views as shown in the drawings and using best practices. Contractor shall provide a minimum two employees to verify all cameras have been pointed and aimed to achieve Owner final approval. A manufacturer's representative may be present on site to answer any questions that may be beyond the technical capability of the Contractor's employees, if the Contractor so elects or by specific request of the Architect or Owner, at no charge to the Architect or Owner.

G. The Contractor shall coordinate with the Architect/Design Consultant on security related construction clean-up and patch work requirements. Security equipment closets and similar areas should be free of accumulation of waste materials or rubbish caused by operations under the Contract. At completion of the Work, remove all waste materials, rubbish, the Contractor's and its subcontractors' tools, construction equipment, machinery and all surplus materials.

H. At their discretion, if the Design Consultant or their designated representative deems the site not ready for inspection/observation, the inspection will be cancelled. The Contractor(s) shall immediately address all issues identified, and shall reschedule the inspection in a timely manner so as not to affect the overall construction schedule.

I. Adjustments and Documentation: energizing and testing the systems, make adjustments and document the setting of controls, configurations, as applicable. Tabulate all data along with an inventory of test equipment, a description of testing conditions and a list of test personnel.

J. Test Documentation: Create and provide complete test reports documenting the results of the each performed on each device, control panel, power supply, and other elements

of the system. Copies of preliminary test data shall accompany copies of performance testing data as part of the Operating and Maintenance submittal.

3.9 PROJECT CLOSEOUT DOCUMENTATION

A. As-Built Drawings

1. Drawings shall be provided to the Architect / Owner / Design Consultant at the time of substantial completion. Final payment will not be recommended until drawings are received and approved by the Architect / Owner / Design Consultant.
2. Unless otherwise requested, Contractor shall provide digital copies of close-out documents, and deliver to the Architect / Owner / Design Consultant electronically.
3. As-Built drawings shall be produced in AutoCAD/Revit in the most current or compatible version and provided electronically in .dwg and/or .pdf format.
4. Drawings shall be provided in the original size as issued by the Architect / Design Consultant.
5. Drawings shall retain the formatting and title block of the original drawings as issued by the Architect / Design Consultant.
6. Provide a conformed set of Drawings as related to the project, depicting the condition of the access control system as installed to include but not limited to:
    a. ASI, PR and Addendum items installed throughout the duration of the project.
7. Provide a hard copy of the conformed set of drawings to be physically stored at the end of the project in a designated Access Control System enclosure. Coordinate with Owner for final storage location.
8. Drawings shall be provided utilizing the original scale and shall include the exact dimensions and locations of the following not limited to:
    a. Access Control System Riser / Signal Flow Diagrams
    b. Access Control System Backboard Layouts
        1) To include access control boards, power supplies, pathways, etc.
    c. Sleeves, Backbone Cabling and Communication pathways
    d. Access Control System device locations and labeling scheme.

B. Operation & Maintenance Manuals

1. Unless otherwise noted, provide O&M manuals electronically to Owner to include all drawings, product datasheets, hardware manuals as related to the project.
2. Coordinate with the Owner for provisioning of physical storage devices (Hardcopy, Flash Drive, CD/DVDs)

C. Spare Parts

1. Contractor to provide spare parts as indicated below:
    a. (1) Intelligent Controller as specified
    b. (1) Door Controller as specified
    c. (1) I/O Boards as specified
    d. (5) Credential Readers as specified
    e. (100) Credential Cards as specified
2. The cost for these spare parts shall be included in the cost of the project. Spare parts are to be turned over to the owner for storage.
3. These parts shall be delivered to the owner at the pre-installation meeting.

D. Manufacturer's Product Warranty

1. Certificate of product warranty shall be provided to the Architect / Owner / Design Consultant at the time of final system acceptance. Final payment will not be recommended until this certificate of product warranty is received and approved by the Architect / Design Consultant.
2. The manufacturer of the solution shall furnish a product warranty as per the specifications starting at final system acceptance.
3. One original and two copies of the Manufacturer's product warranty shall be provided.

E. Contactor's Statement of Warranty

1. Statement of warranty shall be provided to the Architect / Design Consultant at the time of substantial completion. Final payment will not be recommended until statement of warranty is received and approved by the Architect / Design Consultant.
2. Contractor shall furnish a minimum of a one (1) year warranty on all materials, labor and workmanship starting at final system acceptance.
3. One original and two copies of Contractor's warranty terms and conditions to include contact information (i.e. Contractor name, Point of Contact, address, phone number and email address) and start and end date for warranty call outs.

END OF SECTION 281300

SECTION 282300 - VIDEO SURVEILLANCE SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. This section identifies the requirements, technical design, and specifications for the Video Surveillance system at the Kendall County EMS Station NO. 3, located in Bergheim, Texas ("Owner"). The video surveillance system as specified is an industry-standard and includes network video recorder(s)/server(s), VMS software, licenses, cameras, mounts, surge/lighting protection, cabling and any associated software, hardware, or licenses as specified.

B. It is the Contractor's responsibility to review this specification and associated project specifications and drawings in their entirety, prior to bidding on the project. By bidding on this project, the contractor acknowledges that they have read and fully understand these specifications, with no exceptions. Contractor shall review the drawings, specifications, and existing conditions prior to bidding on the project. Any discrepancies shall be brought to the attention of the architect/Design Consultant via request for information (RFI) in writing for evaluation and or clarification. If these items are not brought to the attention of the architect/Design Consultant the more costly or difficult manner, and the better quality or greater quantity of work shall be provided by the contractor in accordance with the architect's/Design Consultant's interpretation at no additional cost to the owner. Contractor shall verify the installation methodology of each device location prior to proceeding with installation. Potential obstructions or mounting conflicts due to changing conditions shall be identified via written RFI for approval with the Owner / Architect / Design Consultant.

C. Contractor shall furnish and install all materials, equipment, and labor necessary to provide a complete and functional turn-key Video Surveillance system regardless of any items not listed or described in this specification or associated drawings.

D. Requirement Sections Table of Contents

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3.4 System Requirements

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3.6 Training Requirements

3.8 Substantial Completion

3.9 Project Closeout Documentation

1.2 RELATED REQUIREMENTS

A. The Drawings, Specifications, General Conditions, Supplementary General Conditions, and other requirements of Division 1 apply to the work specified in Division 28 and shall be complied with in every respect. The Contractor shall examine all the items which make up the Contract Documents and shall coordinate them with the work on the project.

1.3 CONTRACTOR EXPERIENCE REQUIREMENTS

A. The Contractor shall be a certified **Avigilon** Video Management System Partner prior to submitting a bid for the work.

B. The Contractor shall possess all relevant **Avigilon** Manufacturer Certifications (i.e. video surveillance systems, hardware installation, software installation and programming) for both the company and individual technicians prior to submitting a bid for the work.

C. The Contractor shall have an **Avigilon** manufacturer certified technician onsite throughout the duration of the installation phase of the project.

D. The Contractor's Project Manager shall be dedicated to this project for the duration of the project and shall be available for all onsite coordination meetings.

E. The Contractor shall have been in business for a minimum of five (5) years.

F. The Contractor shall have a local office with local technicians and an adequate workforce to complete this project within a 75-mile radius of the project site.

G. The Contractor shall have completed a minimum of five (5) projects similar in size and scope to the Owner's installation, where the systems have been in continuous satisfactory operation for at least one (1) year.

H. Subcontractors shall be identified at the time of bid and comply with the requirements and intentions of these specifications, associated drawings, and related contract documents.

1.4 SUBMITTAL REQUIREMENTS

A. Bid / Proposal Submittal

1. Contractor shall provide as part of their bid/proposal:

a. Breakdown of proposed parts and labor required for the completion of the project. Include documentation showing annual licensing cost of ownership.

b. Proposed construction schedule in a Gant chart format

c. Contractor Safety Plan detailing safety practices around the jobsite.

d. Contractor QA / QC process detailing processes and procedures to ensure quality workmanship during installation and troubleshooting.

e. A detailed description of the installation team(s) that would perform the work.

f. A resume for each of the key project personal.

g. A list of all Sub Contractors and their scope of work shall be identified at the time of bid. All Sub Contractors will fully comply with the requirements and intentions of these specifications, associated drawings, and related contract documents.

B. Pre-Installation Submittal

1. Contractor shall not order, purchase, or install any equipment until pre-installation submittals have been accepted in writing by the Architect / Design Consultant / Owner.

2. The Contractor is responsible for notifying and obtaining written approval via RFI from the Architect / Design Consultant / Owner of any proprietary devices, software, and/or installation processes.

3. Contractor is responsible for obtaining permitting as required in accordance with the authority having jurisdiction (AHJ), local, city, state, federal, and/or applicable law requirements.

4. Contractor shall ensure submittals are submitted in 15 business days of award to ensure all products can be ordered and received on site in order to not cause any delays. Any products having long lead times (more than 60 days) that may negatively impact the schedule shall be clearly identified in writing so the review and approval can be expedited.

5. All submittals shall be submitted in the same sequence as they are listed in the specifications (i.e. product data in the sequence items are listed in the product data section, manufacturer product certifications for company, manufacturer product

certifications for installers, etc.). Submittals not in the proper sequence will not be approved.

6. Contractor shall provide the following as part of their submittal:
    a. Manufacturer product data sheets for each proposed system component.
        1) For product data sheets containing more than one (1) part number or product, the Contractor shall clearly identify the specific part number or product being submitted. Product data sheets without the part number clearly identified will not be approved.
        2) Contractor shall identify any products that are discontinued, end of life, or near end of life, and shall propose equal alternate to the discontinued product in writing.
    b. Manufacturer Product Certifications for Company.
    c. Manufacturer Product Certifications for Installers.
    d. Manufacturer Warranty letters.
    e. Documentation indicating that Contractor has been in business for (5) years.
    f. Address of Contractor's local office within a 75-mile radius of the project site.
    g. Quantity of full-time, local technicians within a 75-mile radius of the project site.
    h. List of five (5) contractor-installed projects of a similar size and scope that have been in operation for at least (1) year. The Contractor shall provide the following information for each project: Project Name, Project Location, Project Start Date, Project Completion Date, Project Start Cost, Project Completion Cost, Brief Description of Project, Client Point of Contact Name and Phone Number.
    i. List of completed and ongoing projects with the Owner. The Contractor shall provide the following information for each project: Project Name, Project Location, Project Start Date, Project Completion Date, Project Start Cost, Project Completion Cost, and Brief Description of Project.
    j. List of subcontractors performing any work on the project. List shall clearly identify the subcontractor's legal name and address, the scope of work to be performed by the subcontractors and the overall percentage of the project being provided by the subcontractor. If there are no subcontractors performing any work on the project, submit a statement on company letterhead clearly indicating no subcontractors will be performing any work on this project.
    k. Manufacturer's Certification Letter confirming that the proposed video surveillance system components do not have any known cybersecurity notices, bulletins, or alerts. If a vulnerability is discovered, the contractor shall notify the Architect / Design Consultant / Owner within 24 business hours. Provide the make and model of the associated equipment and the vulnerability.
    l. Manufacturer Cybersecurity Hardening Guide. If one is not available, provide documentation from the manufacturer stating such.
    m. A complete set of shop drawings to include at a minimum but are not limited to:
        1) Proposed and/or samples of original contractor security schedules. Schedules are <u>not</u> to be copy/paste of schedules provided within the contract documents. Schedules proposed shall be utilized as part of As-Built drawings with coordination with Div. 27 for additional information as required for network components.
            a) Device and equipment schedules shall include at a minimum but are not limited to:
                (1) Device Label
                (2) Device Type

(3) Device Power Requirements

(4) Terminating MDF / IDF / Panel Location

b) Additional networking information as required to include:

(1) Rack

(2) Network switch

(3) IP addresses

(4) Patch panel

(5) Surge/lighting protection

(6) Power source

2) Elevation and Topography Drawings to illustrate the associated devices and equipment and the heights at which they will be installed.

3) Signal Flow Diagram including full security topology.

n. Supplemental documents to include at a minimum but are not limited to:

1) Contractor Safety Plan detailing steps Contractor will take to ensure a safe work environment.

2) Contractor QA/QC Document to include bench testing / initial configuration of all critical system components including but not limited to:

a) System Server(s)

b) Cameras

c) Contractor Furnished Workstations (if applicable)

3) Construction Schedule in a Gant chart format

4) Contractor Cybersecurity Hardening Guide detailing Contractor's internal policies for preventing the introduction of cyberthreats to the Owner's technology / security infrastructure.

a) Contractor Certification Letter utilizing company letterhead detailing the company policies and procedures.

b) Contractor shall provide a cybersecurity plan detailing their internal policy for preventing the introduction of cyberthreats to the Owner's technology / security infrastructure.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. The following sections specifically list the acceptable equipment types and items for this project.

B. All software, hardware, and equipment (from the date of RFP) shall be tested, currently available and commercially off the shelf product. (COTS).

C. All wiring, equipment, and installation materials shall be Commercial Grade, new, and of the highest quality to meet or exceed the performance and features of the equipment and devices specified herein.

D. Written approval must be obtained from the Architect / Design Consultant / Owner for any proprietary or custom software and/or equipment prior to the beginning of the project.

E. All devices shall be installed with the manufacturer recommended mounts and accessories as necessary for the installation locations type as scheduled.

F. Unless otherwise stated, all software and licensing shall be for the most current, up to date version of the system provided. For existing systems, Contractor shall obtain written

verification of the Owner's most current software version and notify via RFI the Architect / Design Consultant / Owner if implementation of the most current software / license version will require an upgrade to the Owner's existing system.

G. Architect / Design Consultant / Owner will have final determination of acceptability of all proposed equipment and must approve submitted equipment prior to purchase or installation.

H. Proposed equivalent items must be approved in writing by the Architect / Design Consultant / Owner prior to purchase or installation. Proposed equivalent items must meet or exceed these specifications and the specifications of the specified item.

I. In the event a manufacturer's specified product or part number has changed or is no longer available, Contractor shall submit a formal RFI for an appropriate substitute.

J. In the event of a discrepancy between the specifications and the drawings, the greater quantity and/or better quality will be furnished at no additional cost to the owner.

K. For listed products with no part number specified, Contractor shall provide a product that meets the performance requirements of these specifications, industry standard practices, and intended application.

L. Labels on all cabling, materials, and equipment must indicate a nationally recognized testing laboratory.

M. Contractor shall review all products specified and required for this project to determine if there are any lead times for any products that may cause any delay. Contractor shall clearly identify any concerns with lead times in writing to the Architect / Design Consultant / Owner. If the Contractor does not identify any concerns with products having long lead times, it will be understood there are no long lead time issues and the Contractor will have all products on-site when needed to complete the job as per the project schedule.

N. Any quantities listed are for reference only, contractor is responsible for furnishing materials as required to provide a fully functional turkey system. Where quantities are not noted, Contractor shall refer to drawings and schedules to determine exact quantities.

2.2 ACCEPTABLE MANUFACTURERS

A. Video Surveillance System Manufacturer

1. Avigilon

B. Video Surveillance System Software

1. Avigilon Control Center™ 7 (Enterprise)

C. Video Surveillance System Licensing (as required)

1. Enterprise ACC license

a. ACC7-ENT

2. Enterprise ACC failover license

a. ACC7-ENT-FO

D. Video Surveillance System Hardware

1. Video Surveillance Server

a. The Video Surveillance Server shall consist of one of the following:

1) Avigilon

2) BCDVideo

3) Dell

4) Or other approved equivalent

b. The Video Surveillance Server(s) shall be sized accordingly to accommodate the following recording parameters based on camera(s) specified:
   1) 15 Frames Per Second (FPS)
   2) Maximum resolution per camera(s) specified
   3) 30 Retention Days (Minimum)
   4) 100% Motion Detection Recording
   5) H.265 Compression

c. The Video Surveillance Server(s) shall also be sized accordingly to accommodate the following additional parameters:
   1) RAID 1 Configuration
   2) Server Failover
   3) Redundant Power Supplies
   4) UPS Battery Back-up
   5) 20% Future Expansion

2. Video Surveillance Cameras
   a. Indoor 2 MP dome with IR Single Lens
      1) Avigilon 2.0C-H5A-DO1-IR
         a) Acceptable Mounts
            (1) Ceiling Tile Support
               (i) Caddy – 512HD (By Div. 28)
               (ii) Double Gang Backbox (By Div.28)
               (iii) Dual Gang Mud Ring (By Div. 28)
   b. Indoor/Outdoor 9 MP (3x 3MP) 270° Panoramic Multisensor Camera with IR
      1) Avigilon 9C-H5A-3MH
         a) IR Ring Module
            (1) H4AMH-AD-IRIL1
         b) Acceptable Mounts
            (1) Pendant Mount
               (i) H5AMH-AD-PEND1
            (2) Dome Cover
               (i) H5AMH-DO-COVR1
            (3) Wall Mount
               (i) WLMT-1001
3. Rack Mounted Uninterruptible Power Supply (UPS) / Battery Backup
   a. APC SMT2200RM2UC
   b. Or other approved equivalent
4. Video Surveillance System Surge Suppression Device
   a. Provide surge suppression devices consisting of one or combination of the following:
      1) Head End Equipment (MDF/IDF)

a) Ditek DTK-RM24NETS

(1) DTK-NETMS (Modules)

b) Or other approved equivalent

2) Device End (Edge)

a) Ditek DTK-MRJPOE

b) Or other approved equivalent

E. Video Surveillance System Data Cabling

1. Reference Division 27 Specifications

F. Pathway Cable Support

1. Panduit J-Mod Cable Support System
2. Erico – CADDY CAT LINKS J-Hook Series
3. Panduit Plenum Rated Velcro Hook & loop (velcro) (Black)
4. Permanent Labels for Copper Cables
   a. Refer to Div. 27 specifications for cable labeling requirements

G. Fire Stop / Sealants

1. STI Spec Seal
2. STI EZ Path
3. STI EZ-Firestop Grommet
4. 3M Products
5. Masterseal NP1
6. Or approved equal

PART 3 - EXECUTION

3.1 CODES, STANDARDS, REGULATIONS

A. American National Standards Institute (ANSI)

B. American Society for Testing and Materials (ASTM)

1. ASTM B 1 (2001; R 2007) Standard Specification for Hard-Drawn Copper Wire
2. ASTM B 8 (2004) Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
3. ASTM D 1557 (2007) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
4. ASTM D 709 (2001; R 2007) Laminated Thermosetting Materials

C. Alliance for Telecommunications Industry Solutions (ATIS)

D. Building Industry Consulting Service International (BICSI)

1. Telecommunications Distribution Methods Manual 13th Edition
2. Outside Plant Design Reference Manual 5th Edition
3. ANSI/BICSI 002-2011, Data Center Design and Implementation Best Practices
4. NECA/BICSI 568-2006 – Standard for Installing Commercial Building Telecommunications Cabling
5. NECA/BICSI 607-2011, Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings

E. Federal Communications Commission (FCC)

1. FCC Part 15, Radiated Emissions Limits, revised 1998
2. FCC Part 68, Connection of Terminal Equipment to the Telephone Network, revised 1998
3. FCC Part 76, Cable Television Service, revised 1998
4. Advanced Encryption Standard (AES) (FIPS197)

F. Homeland Security Presidential Directive 12 (HSPD12)

G. Insulated Cable Design Consultants Association (ICEA)

1. ICEA S-87-640 (2006) Fiber Optic Outside Plant Communications Cable
2. ICEA S-98-688 (2006) Broadband Twisted Pair, Telecommunications Cable Aircore, Polyolefin Insulated Copper Conductors
3. ICEA S-99-689 (2006) Broadband Twisted Pair Telecommunications Cable Filled, Polyolefin Insulated Copper Conductors

H. International Electrotechnical Commission (IEC)

I. Institute of Electrical and Electronics Design Consultants, Inc. (IEEE)

1. IEEE Standard 81-1983, IEEE Guide for Measuring Earth Resistance, Ground Impedance, and Earth Surface Potential of a Ground System
2. IEEE Standard 1100-1999, Recommended for practice for Powering and Grounding Sensitive
3. Electronic Equipment in Industrial and Commercial Power Systems (IEEE Emerald Book)
4. IEEE C2 (2007; Errata 2007; INT 2008) National Electrical Safety Code
5. IEEE Std 100 (2000) The Authoritative Dictionary of IEEE Standards Terms

J. International Organization for Standardization (ISO)

1. International Organization of Standardization/International Electrotechnical Commission (ISO/IEC)
2. ISO/IEC 11801, Information Technology-Generic Cabling for Customer Premises, 1995
3. ISO/IEC 14443-3:2011 – Identification Cards
4. ISO/IEC 14763-1, Information Technology-Implementation and Operation of Customer Premises Cabling-Administration, 1999

K. National Cable Television Association (NCTA)

L. National Electrical Contractors Association (NECA)

1. NECA 1-2015 Good Workmanship in Electrical Construction

M. National Electrical Manufacturers Association (NEMA)

1. NEMA C62.61 (1993) Gas Tube Surge Arresters on Wire Line Telephone Circuits

N. National Fire Protection Association (NFPA)

1. NFPA-70, National Electrical Code
2. NFPA-75, Protection of Electronic Computer Data Processing Equipment.
3. NFPA-101, Life Safety Code
4. NFPA-297, Guide on Principles and Practices for Telecommunications Systems
5. NFPA-780, Standard for the Installation of Lightning Protection Systems.

O. National Institute Standards and Technology (NIST)

P. Occupational Safety and Health Administration (OSHA)

Q. Security Industry Association (SIA)

R. Telecommunications Industry Association (TIA)

1. ANSI/TIA-568.0-D-1, Generic Telecommunications Cabling for Customer Premises.
2. ANSI/TIA-568.1-D, Commercial Building Telecommunications Cabling Standard.
3. ANSI/TIA -568.0-D.2, Balanced Twisted-Pair Telecommunications Cabling and Components Standard.
4. ANSI/TIA-568.3-D-1, Optical Fiber Cabling Components Standard.
5. ANSI/TIA–569-E Commercial Building Standard for Telecommunications Pathways and Spaces.
6. ANSI/TIA-606-C, Administration Standard for the Telecommunications Infrastructure.
7. ANSI/TIA-607-D, Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises.
8. ANSI/TIA-758-B, Customer-Owned Outside Plant Telecommunications Infrastructure Standard.

S. U.S. Department of Agriculture (USDA)

1. RUS 1755 Telecommunications Standards and Specifications for Materials, Equipment and Construction
2. RUS Bull 1751F-643 (2002) Underground Plant Design
3. RUS Bull 1751F-815 (1979) Electrical Protection of Outside Plant
4. RUS Bull 1753F-201 (1997) Acceptance Tests of Telecommunications Plant (PC-4)
5. RUS Bull 1753F-401 (1995) Splicing Copper and Fiber Optic Cables (PC-2)
6. RUS Bull 345-65 (1985) Shield Bonding Connectors (PE-65)
7. RUS Bull 345-72 (1985) Filled Splice Closures (PE-74)
8. RUS Bull 345-83 (1979; Rev Oct 1982) Gas Tube Surge Arrestors (PE-80)

T. Underwriters Laboratories, Inc. (UL)

1. UL 294 Standard for Video Surveillance System Units
2. UL 294B Standard for Power Over Ethernet (PoE) Power Sources for Video Surveillance Systems and Equipment
3. UL 109 Standard Method for Flame Tests of Flame-Resistant Fabrics and Films
4. UL 1076 Standard for Proprietary Burglar Alarm Units and Systems

3.2 EXECUTION - GENERAL REQUIREMENTS

A. Contractor shall comply with the requirements of local Authority Having Jurisdiction (AHJ), State of Texas, the National Fire Protection Association (NFPA), and the National Electrical Code (NEC). If the Contractor identifies any item in the plans or specifications that will not strictly comply with the aforementioned laws, ordinances, and rules, the matter shall be referred to the Architect / Design Consultant for direction before proceeding with that part of the work.

B. Contractor shall meet the specifications and standards from the latest NFPA and NEC publications. In the event of any conflicts between Standards and Codes the more stringent shall take precedence.

C. The Contractor shall install the materials in accordance with these specifications and the manufacturer's installation guidelines. Equipment and materials installed by the Contractor shall be free of defects and damage.

D. No deviations from the plans, details or specifications shall be made without full consent in writing of the Architect / Design Consultant. The Contractor shall have written approval from the Architect / Design Consultant for any additional work beyond the Contract Documents prior to beginning such work.

E. Prior to execution, Contractor shall verify no changes in software, licensing or hardware versions have occurred since the bidding of the project. In the event of any changes, Contractor shall verify system compatibilities with their proposed design, and notify via RFI the Architect / Design Consultant / Owner if the newest version(s) will require any upgrades / additional costs to the existing system(s).

F. In the event site conditions do not allow the contractor to follow the execution requirements specified herein or in the provided details, the Contractor shall submit via RFI an alternative means and methods that is approved in writing by the Architect / Design Consultant / Owner.

G. The Contractor shall obtain written permission from the Architect / Design Consultant / Owner before proceeding with any work that would necessitate cutting into or through any part of the building structure such as, but not limited to: girders, beams, floors, walls, roofs, and/or ceilings.

H. If the Contractor does not obtain written approval from the Architect / Design Consultant / Owner prior to proceeding with the work, the contractor shall not be reimbursed for the work.

I. Contractor shall notify the Architect / Design Consultant / Owner a minimum of (2) weeks prior to beginning work and will participate in a pre-construction meeting with the Architect / Design Consultant / Owner to perform a walkthrough, review the scope of work, schedule, and escalation procedures.

J. The Contractor shall maintain a work area free of debris, trash, empty cable reels, scrap cable, etc., and dispose of such items on a daily basis and return the site to the original state of cleanliness. The Contractor shall not use Owner's facilities for the disposal of excess or scrap materials.

K. Contractor shall be responsible for the repair of any damage caused by the contractor during the installation.

L. Contractor shall test all cables prior to and post installation. By failing to perform this testing operation, the Contractor shall accept the cable as compliant and assume all liability for the replacement of the cable at no cost to the Owner should it be found defective at a later date.

M. Contractor shall maintain a set of working specifications, design drawings, schedules, and record drawings to be kept on site at all times and shall update the record drawings with any changes on a weekly basis. Record drawings shall be made available for inspection at the request of the Architect / Design Consultant / Owner.

N. Equipment and materials shall be consistent throughout the installation. Where multiple units of the same type of equipment and materials are required, these units shall be a standard product with the same manufacturer and model number.

O. Equipment and materials shall be delivered and stored in accordance with the manufacturer's guidelines at the Contractor's expense.

P. Contractor shall make all stored equipment and materials available for inspection at the request of the Architect / Design Consultant / Owner.

Q. All equipment and material used in the installation shall be approved by the manufacturer for the environment in which it is being installed.

R. All devices shall be installed flush, plumb, and (where required) centered on the wall, ceiling tile or structure for which it is being installed, unless otherwise noted.

S. Devices installed in public spaces shall be mounted and secured using tamper-proof security fasteners unless otherwise noted.

T. Cables shall be properly supported in accordance with industry standards at all times. Improperly supported cables shall be corrected by the Contractor at no cost to the Owner.

U. Contractor shall be responsible to properly protect information outlets from damage by other trades during construction.

V. Cables shall be routed at 90-degree angles to the building structure. At no time shall a diagonal pull be installed.

W. The Contractor shall not install cables in conduits or sleeves without nylon bushings. Cables installed through conduits or sleeves without nylon bushings shall be removed and replaced at no cost to the Owner.

X. The manufacturer and contractor shall take positive measures to prevent the introduction of cybersecurity threats to the Owners technology infrastructure. These measures shall include but are not limited to:

1. The contractor shall scan contractor owned equipment for cyber threats such as viruses, malware, ransomware, etc., prior to connecting the contractor owned devices to the Owners network.

2. Ensure all technicians installing or configuring equipment are trained on the prevention of introduction of cyber threats to electronics, i.e. servers, and other associated equipment.

3. All project documents shall be properly securely stored behind encryption and password protection to avoid unauthorized distribution of documents.

3.3 COORDINATION REQUIREMENTS

A. The Contractor is responsible for the coordination of the following items and their respective disciplines included but not limited to.

B. Coordinate with the Architect to ensure that:

1. Adequate conduit is provided and that equipment backboxes are adequate for system installation.

2. Adequate communication infrastructure and power has been provided and properly located for the security system equipment.

3. Finishes and colors of all equipment visibly installed in public areas. Submit all finish and graphics for all equipment to the Architect for approval prior to installation.

4. Camera views are not obstructed by landscaping, awnings, or any other obstacles.

5. Mounting techniques are in compliance with construction techniques.

6. Camera location and field of views are adequate and meets Owner's expectations.

C. Coordinate with the Division 26 contractor for the following:

1. Power requirements, conduit sizes/pathways, sleeves, back boxes, grounding, and bonding requirements of security devices in the following locations:

a. Interior of the building

b. Exterior of the building

c. Pole, pedestals, canopies, awnings, building architectural surface, etc.

d. Special conditions (clean room, hazardous areas, roof top mounted devices, etc).

e. License Plate Recognition (LPR) exact camera placement requirements.

2. Coordinate location and termination of earth ground for all device specified herein as required per manufacturer installation requirements.

D. Coordinate with the Division 27 contractor for the following:

1. Installation and power requirements of network infrastructure associated to the specified system.

2. Associated patch cable lengths and quantities required for the specified system.

3. Location, power, and backup requirements for rack mount equipment.

4. Mounting and installation of injectors, midspans, extenders, surge protectors, etc.

E. The Contractor is responsible for coordinating all VMS programming requirements with the Owner / Architect / Design Consultant.

F. The Contractor shall coordinate with the Owner prior to installation for the following:

1. Network IP addressing for networked system equipment, servers, and devices.

2. Device labeling scheme

3. Firmware/software updates

4. Client workstations requirements and locations

5. Location of rack mount equipment.

6. Locations, type, programming, configuration, and Owner's final expectations for any Contractor Furnished Contractor Installed (CFCI) equipment and devices.

7. Uninterruptible Power Supply (UPS) requirements.

8. Painting of exposed, publicly visible conduit pathways

9. Camera Views (Owner's Written Acceptance Required)

10. Programming including, but not limited to:

a. Camera Configuration

b. Recording Parameters

c. Live View Parameters

d. Admin / User Settings

e. Camera Analytic Detection and Event Triggering

f. VMS Software Configuration

g. User / Admin Groups

h. Camera Views

3.4 SYSTEM REQUIREMENTS

A. General

1. The Video Surveillance System (VMS) shall consist of server(s), software, licensing, workstations, cameras, power source, grounding/bonding, Video Surveillance cabling, and all other peripheral components as indicated on the drawing and specified herein.

2. Any devices associated with the installation shall have the latest firmware updates downloads via Owner approved secure link from the system software and/or remotely from the manufacturer.

3. All Video Surveillance software, equipment and system requirements shall be installed per their respective Manufacturer Installation Guidelines.

4. Programming and data entry to be provide by the Contractor. Contractor shall program the Video Surveillance System to provide the following basic functions included but not limited to:

5. When programming and data entry for the system is to be completed by Owner, Contractor is responsible for initial programming to ensure the installed field devices, media converters, etc., are communicating to the head-end equipment, so that the Owner can complete the necessary programming and shall assist in troubleshooting in the event they do not.

B. Video Surveillance System (VMS) Software

1. Server/Client/Workstation/Mobile Application Software

a. The VMS software shall be installed as the most current version; contractor shall coordinate with Owner prior to the upgrade/install to identify and evaluate any software conflicts. Conflicts shall be brought to the attention of the Architect/Design Consultant prior to installation via written Request for Information (RFI). Contractor shall coordinate the install and configure software as required to provide a full turnkey VMS.

C. Video Surveillance System Licensing

1. Contractor shall be responsible for providing and applying all necessary licensing key(s) for the specified system(s) as required by the manufacturer(s) for a fully functioning Video Surveillance System.

2. Contractor shall maintain a secured document with all license key(s) information applicable to this project. All license key(s) are property of the Owner and shall be kept secured at all times and then surrendered to the Owner at the end of the project.

D. Video Surveillance System Hardware

1. Video Surveillance Server

a. The Video Surveillance server(s) shall meet or exceed the VMS manufacturers requirements for the size and complexity of the Video Surveillance system being installed.

b. Contractor shall coordinate with Architect / Design Consultant / Owner for server(s) mounting location, communications, power, and additional requirements.

c. Contractor shall coordinate with the Architect / Design Consultant / Owner for any updates or changes to the submitted equipment as a result of changes technologies or updated requirements prior to installation

2. Communications

a. Communication between servers, workstations, and networked based edge devices will communicate using the Owner provided data network unless otherwise noted. Coordinate with Owner for network configuration requirements.

b. The VMS shall also support end to end encryption unless otherwise noted.

E. Video Surveillance Cameras

1. The Contractor shall have all on-site equipment, and personnel necessary to install, program, and troubleshoot devices during and after installation.

2. Unless otherwise stated, all cameras shall receive power through Power over Ethernet. Contractor is responsible for ensuring the power output of the network switch will meet the power requirements of the cameras to be installed. Any additional power will be the responsibility of the contractor to provide.

3. PoE Injectors / Midspans / Extenders provided by the Contractor shall be securely mounted to the rack or wall per the manufacturer installation guidelines and / or Owner's standards.

4. The Contractor shall energize and commission equipment in accordance with manufacturer's instructions and guidelines. All installed cameras, mounts, accessories, and fasteners shall be properly rated for the environmental conditions in which they will be installed. Contractor is responsible for sealing and making watertight all exterior penetrations and equipment.

5. The Contractor is responsible for all the initial configuration of camera settings, IP address settings, recording settings, presets, naming conventions, etc. unless otherwise noted.

6. Default admin account usernames and passwords shall be reconfigured prior to connecting to the Owner's network. New admin accounts and passwords shall be Owner Provided. Account passwords and settings shall be held in confidence by the Contractor and secured throughout the duration of the project to prevent unauthorized access.

7. As part of initial installation, Contractor is responsible for focusing and aiming the camera in the direction as indicated in the drawings. Unless otherwise stated, camera lenses shall provide the maximum field of view coverage to the area to provide a usable, level, clear image, pending Owner's final approval. Contractor shall plan for a minimum of one additional trip to make final adjustments of camera field of views.

F. Surge Protection / Lightning Arrestors

1. Protect all exterior or interior devices, control, power, signal cables and conductors that are power surges. Each surge protector shall be UL Listed.

2. Unless otherwise noted, surge protection devices shall be installed at both the edge and head end of the cabling run.

3. Surge devices shall be installed as close as accessibly possible to the equipment they are protecting.

4. Surge Protection shall be properly installed in an accessible ceiling or enclosure space to allow for cable removal during troubleshooting.

5. Include surge protection device locations on as-builts and shop drawings.

6. Provide protection against spikes, surges, noise, and other line problems for all system equipment and components.

7. Properly ground surge protection devices per the manufacturer installation requirements.

G. Video Surveillance Cabling

1. Unless otherwise noted, all data cabling from end to end to support the Video Surveillance System and all related IP devices shall be provided, installed, and maintained by Div. 27 / the Owner.

H. Device Labeling

1. Unless otherwise, all installed devices shall be labeled. Contractor shall verify device numbering scheme and Owner's current naming convention standard in writing in advance via RFI prior to generating any labels.

2. Unless otherwise stated, all labels shall be machine printed and adhered to the device in a location that is visible and legible to the naked eye.

3. All labeling in the field shall match the same labeling scheme in the closeout documents.

4. Refer to Div. 27 specifications for data network device cabling requirements.

I. Grounding and Bonding

1. All grounding and bonding shall be performed by a licensed electrical contractor to ensure the electrical integrity of the low voltage system and devices specified herein per federal / state / local codes and standards.
2. Contractor shall notify the Architect / Owner / Design Consultant via written RFI of any site conditions or installations that will require additional coordination.
3. Contractor shall ensure proper grounding of shielded or non-shielded cabling and devices conform to the specified devices manufacturer's installation guidelines.
4. The Division 28 Contractor is responsible for coordinating with the Division 26 Contractor for grounding and bonding security devices per applicable codes and standards.

J. Conduit, Boxes and Raceways (For Reference Only - By Division 26)

1. Install all conduit necessary for a complete installation but not limited to: in finished areas, in concealed areas, in chases, in furring's, in concrete slabs and/or above suspended ceilings. No exposed conduit shall be installed within public areas.
2. Conduit shall be carefully installed, properly and adequately supported as required to comply with the requirements outlined herein and as required by the NEC to provide a neat, industry-standard installation. Horizontal conduit runs shall be supported by clamps, pipe straps, special brackets or heavy iron tie, tied to the black iron structural members supporting the ceiling. Fastening of conduit to masonry walls, floor or partitions require malleable pipe clips with screws and suitable expansion sleeves.
3. All conduits shall be cut accurately to measurements established at the building and shall be installed without springing or forcing.
4. All required inserts shall be drilled-in and all openings required through concrete or masonry shall be saw cut or core drilled with tools specifically designed for this purpose.
5. Swab out and remove all burrs from conduit before any wires are pulled.
6. Lay out and install conduit runs as to avoid proximity to hot pipes. In no case shall a conduit be run within 75 mm of such pipes, except where crossings are unavoidable and then the conduit shall be kept at least 25 mm from the covering of the pipe crossed.
7. Provide fire stops where conduits penetrate fire rated walls and/or floors.
8. All conduit installation, whether run exposed or concealed, shall be approved prior to installation by the Architect.

K. High Voltage (120VAC) Power Requirements (For Reference Only – by Division 26)

1. 120VAC AC power dedicated to security shall be provided by the electrical contractor for the Video Surveillance system as indicated on drawings. Coordinate with the Architect to establish locations of security dedicated 120VAC AC circuits.
2. Connect to the AC power (provided by electrical contractor) and provide UL listed power supplies and transformers to distribute low voltage power to the system components as required.
3. Provide all conduit and wiring from the AC power facilities to the Video Surveillance / Power Supply Enclosures.
4. Provide Mechanical separation to isolate 120VAC wires from other low voltage cabling. Low voltage cabling shall not route over/under/parallel to 120VAC wires.

3.5 TESTING REQUIREMENTS

A. The Contractor shall perform a burn-in of the system that is in accordance with the manufacturer's installation guidelines.

1. All devices shall be powered up and tested in a phased approach in a controlled testing environment on or off premise (to be coordinated with the Owner).
2. Update firmware with most up to date version (to be coordinated with the Owner).

B. Contractor shall conduct a five (5) day burn in test. Each system hardware device shall remain operational during the burn-in test for a minimum of eight (8) hours without failure.

1. Contractor shall provide successful burn-in results in writing to the Architect / Design Consultant prior to final acceptance.

C. Security Contractor shall conduct a complete QA/QC test of the entire system and provide a written report of the test results (Punchlist). The tests shall include, but not limited to:

1. Hardware
2. Software
3. Network Connectivity
4. Device Power
5. Configure system device settings
6. Setting camera views (aim & focus)
7. Archiving of video footage

D. It is the responsibility of the Contractor to verify that all devices, equipment, software, interfaces, sub-system interfaces and integrations are fully functional and operational.

E. Contractor shall rectify all issues discovered during the QA/QC process and shall document these corrections via a Contractor provided punch-list.

1. At a minimum the punch-list shall contain:
   a. Date of the item identified
   b. Description of the discrepancy with photographs as necessary.
   c. Date the item was rectified

F. All QA/QC items shall be corrected, and an electronic report surrendered to the Architect / Design Consultant prior to calling for Substantial Completion.

3.6 TRAINING REQUIREMENTS

A. Training outline with Owner sign off specific to the vertical market served.

B. Provide for (4) hours of training for (8) persons on each system.

C. The Contractor shall closely coordinate with the Owner to establish a training syllabus and schedule. Submit a comprehensive training curriculum to the Owner once all preliminary coordination is complete. The Owner will revise and comment on the curriculum as required.

D. Contractor training shall be conducted onsite. Training shall be conducted by a Factory Certified trainer from the Manufacturer.

E. Operator training shall be structured to provide the appropriate users the information required for them to be able to perform the following tasks:

1. All operating procedures
2. System configuration
3. Camera Configuration
4. Rules Configuration
5. Alarm acknowledgement, alarm response logging, and map graphics functionality

6. Manipulation of cameras and presets.

7. Archiving Recorded Video

F. Administrative training shall include, but not be limited to the following:

1. All operating system procedures, configuration variables and graphic user interface (GUI)

2. Report generation

G. Record, label, and catalog all training on DVD and "user's manual" written specifically for the Owner personnel onsite, for daily routine operations of the systems. Provide the DVD and user's manual to the Owner for future in-house training sessions and / or reviews. Furnish all temporary equipment necessary for recording all training sessions. Maintain accurate and up-to-date time sheets of all training sessions.

H. The Owner reserves the right to use any excess training hours, not used by the time of system completion, for future training as requested until the total number of training hours has been completed.

3.7 FIELD OBSERVATIONS

A. A minimum of ten business days in advance, Contractor shall notify the Design Consultant and Owner as to the readiness for a Field Observation for the following at a minimum but not limited to:

1. Rough-In Observation – after conduits have been installed, but before walls have been installed.

2. Above Ceiling Observation – after cabling has been installed, but before ceilings have been installed.

3. Final Site Observation – a minimum of two weeks before Substantial Completion.

B. During Design Consultant's Final Site Observation of the installed systems, provide a minimum of one factory-trained/certified technician on the operation of all installed systems for up to (1) 8-hour day to assist with Design Consultant's functional testing.

C. Non-Conforming Work (Punch-List)

1. After receipt of written notice of deficiencies (Punch-List), Contractor shall correct all defective work within ten business days. If the work has been identified to be corrected by the Architect/Design Consultant, the Contractor shall remediate it in conformance with the contract documents at no cost to the Owner.

3.8 SUBSTANTIAL COMPLETION

A. It is the responsibility of the Contractor to ensure that all punch list items are 100% complete. The Contractor shall complete an internal Quality Assurance / Quality Control inspection, make all corrections, document the deficiencies and corrections prior to requesting for any further inspections with the Architect / Owner / Design Consultant.

B. Prior to any Substantial Completion, the Contractor shall submit a minimum two sets of preliminary (first draft) Record Drawings (As-Builts) to the Architect/Design Consultant. The preliminary Record Drawings are to be used by the Architect/Design Consultant to conduct the system substantial completion inspection.

C. The Contractor shall notify the General Contractor / Architect / Design Consultant that all the items noted above have been completed and the installation is ready for inspection.

D. The Architect / Design Consultant shall schedule an inspection of the installation with the General Contractor and the Installing Contractor(s) present.

E. The Substantial Completion Inspection shall consist of the following:

1. The Project Manager/Superintendent and Installation Technician shall be on site with all tools, materials, and equipment ready to resolve any minor issues identified.

2. The Design Consultant or designated representative shall visually inspect the installation in accordance with the official design documents.

    a. The Contractor shall be prepared to remove and reinstall (minimum 10%) randomly selected security devices to inspect the mounting, cabling, terminations, connectors, labeling, tampers.

3. Punch list items shall be identified and documented in a provided punch list with a date and description of the issue found, and a date the discrepancy was addressed and the resolution.

F. Provide all personnel, equipment, and supplies necessary to perform all site testing. All video surveillance cameras shall be pointed and aimed in the views as shown in the drawings and using best practices. Contractor shall provide a minimum two employees to verify all cameras have been pointed and aimed to achieve Owner final approval. A manufacturer's representative may be present on site to answer any questions that may be beyond the technical capability of the Contractor's employees, if the Contractor so elects or by specific request of the Architect or Owner, at no charge to the Architect or Owner.

G. The Contractor shall coordinate with the Architect/Design Consultant on security related construction clean-up and patch work requirements. Security equipment closets and similar areas should be free of accumulation of waste materials or rubbish caused by operations under the Contract. At completion of the Work, remove all waste materials, rubbish, the Contractor's and its subcontractors' tools, construction equipment, machinery and all surplus materials.

H. At their discretion, if the Design Consultant or their designated representative deems the site not ready for inspection/observation, the inspection will be cancelled. The Contractor(s) shall immediately address all issues identified, and shall reschedule the inspection in a timely manner so as not to affect the overall construction schedule.

I. Adjustments and Documentation: energizing and testing the systems, make adjustments and document the setting of controls, configurations, as applicable. Tabulate all data along with an inventory of test equipment, a description of testing conditions and a list of test personnel.

J. Test Documentation: Create and provide complete test reports documenting the results of the each performed on each device, control panel, power supply, and other elements of the system. Copies of preliminary test data shall accompany copies of performance testing data as part of the Operating and Maintenance submittal.

3.9 PROJECT CLOSEOUT DOCUMENTATION

A. As-Built Drawings

1. Drawings shall be provided to the Architect / Owner / Design Consultant at the time of substantial completion. Final payment will not be recommended until drawings are received and approved by the Architect / Owner / Design Consultant.

2. Unless otherwise requested, Contractor shall provide digital copies of close-out documents, and deliver to the Architect / Owner / Design Consultant electronically.

3. As-Built drawings shall be produced in AutoCAD/Revit in the most current or compatible version and provided electronically in .dwg and/or .pdf format.

4. Drawings shall be provided in the original size as issued by the Architect/Design Consultant.

5. Drawings shall retain the formatting and title block of the original drawings as issued by the Architect/Design Consultant.

6. Provide a conformed set of Drawings as related to the project, depicting the condition of the Video Surveillance system as installed to include but not limited to:

    a. ASI, PR and Addendum items installed throughout the duration of the project.

7. Provide a hard copy of the conformed set of drawings to be physically stored at the end of the project in a designated Video Surveillance System enclosure. Coordinate with Owner for final storage location.
8. Drawings shall be provided utilizing the original scale and shall include the exact dimensions and locations of the following not limited to:
    a. Video Surveillance System Riser / Signal Flow Diagrams
    b. Video Surveillance System Backboard Layouts
        1) To include Video Surveillance boards, power supplies, pathways, etc.
    c. Sleeves, Backbone Cabling and Communication pathways
    d. Video Surveillance System device locations and labeling scheme.

B. Operation & Maintenance Manuals
1. Unless otherwise noted, provide O&M manuals electronically to Owner to include all drawings, product datasheets, hardware manuals as related to the project.
2. Coordinate with the Owner for provisioning of physical storage devices (Hardcopy, Flash Drive, CD/DVDs)

C. Manufacturer's Product Warranty
1. Certificate of product warranty shall be provided to the Architect / Owner / Design Consultant at the time of final system acceptance. Final payment will not be recommended until this certificate of product warranty is received and approved by the Architect/Design Consultant.
2. The manufacturer of the solution shall furnish a product warranty as per the specifications starting at final system acceptance.
3. One original and two copies of the Manufacturer's product warranty shall be provided.

D. Contactor's Statement of Warranty
1. Statement of warranty shall be provided to the Architect/Design Consultant at the time of substantial completion. Final payment will not be recommended until statement of warranty is received and approved by the Architect/Design Consultant.
2. Contractor shall furnish a minimum of a one (1) year warranty on all materials, labor and workmanship starting at final system acceptance.
3. One original and two copies of Contractor's warranty terms and conditions to include contact information (i.e. Contractor name, Point of Contact, address, phone number and email address) and start and end date for warranty call outs.

END OF SECTION

SECTION 28311 - DIGITAL ADDRESSABLE FIRE ALARM SYSTEM

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. General:

1. This specification describes an integrated intelligent fire alarm detection, emergency communication, and voice notification system. The control panel shall be intelligent, device intelligent, analog detecting, low voltage and modular, with digital communication techniques, in full compliance with all applicable codes and standards. The features and capacities described in this specification are required as a minimum for this project and shall be furnished by the successful contractor.
2. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section.
3. The systems shall be in full compliance with National and Local Codes.
4. The systems shall include all required hardware, raceways, interconnecting wiring and software to accomplish the requirements of this specification and the contract drawings, whether specifically itemized herein.
5. The systems as specified shall be supplied, installed, tested and approved by the local AHJ, and turned over to the owner in an operational condition.
6. In the interest of job coordination and responsibilities the installing contractor shall contract with a single supplier for fire alarm equipment, engineering, programming, inspection, and tests, and shall be capable of providing a "UL Listing Certificate" for the complete system.
7. The systems specified shall meet all project requirements. All systems approved shall meet all the requirements spelled out in this specification. System approval shall be in writing by the Designer of Record and a copy shall be submitted with the system submittals.

B. The fire alarm system as shown on the Contract Documents is schematic in nature and indicates the areas to be covered and the types of devices to be utilized. The final design of the system shall be performed by a Fire Alarm Planning Superintendent and shall meet the requirements of the governing codes and the AHJ. The actual quantities and exact placement of devices shall be determined by the governing codes and the device ratings being furnished by the fire alarm system vendor. This design is for permit only.

C. System Description:

1. The system shall include, but not be limited to, all control equipment, network nodes, power supplies, signal initiating and signaling devices, conduit, conductors, fittings, and all other accessories required to provide a complete and operable system.
2. The addressable fire alarm and voice notification system shall be a complete, electrically supervised, non-coded, intelligent multiplex fire alarm and emergency communication system conforming to NFPA 72 and UL 864. The system shall have a microprocessor-based operating

system having the following capabilities, features, and capacities:

a. System shall provide an output port for monitoring purposes by external systems. Communications to an external system shall be RS-232 or RS-485 communications.

b. Communications between network nodes, each supporting an interactive, self- standing, intelligent local control panel, with system wide display.

c. Each node shall be an intelligent microprocessor-based device communicating with the network in a peer-to-peer manner. Decisions pertinent to the network shall be distributed among the nodes such that there is no need for a central controller. Dedicated main control panel systems will not be acceptable.

d. Information on any point connected to any node in the network shall be accessible to the network, also called "public" point information may be incorporated into custom control programming of any node and operated upon as though the point was physically connected to that node.

e. Points within each node shall be able to be grouped by area, type of device, type of function or any user selectable category and custom labeled as a "point list". A point list shall be acted upon as though it is a point for purposes of interaction with node custom control programming.

   1) Each smoke detector labeled shall include the control panel ID. The intent of this requirement is to ensure ease of maintenance and troubleshooting with smoke detectors.

f. System shall be capable of on-site loading and editing of special instructions and operating sequences.

g. System shall be capable of on-site programming.

h. Annunciation device circuits individually configurable on site to provide, upon activation, a fast march time, slow march time, temporal code, Positive, Non- interfering, and Successive (PNIS) code or a master code, until silenced or reset upon any output circuit. The PNIS coded pulse on and off time may be selectable on site to provide 16 different duty cycles between 1/4 second and 5 seconds.

i. The local system shall provide status indicators and control switches for all of the following functions:

   1) Audible and visual notification alarm circuit zone control.
   2) Status indicators for sprinkler system water-flow and valve supervisory devices.
   3) Any additional status or control functions as indicated on the drawings, including but not limited to; emergency generator functions, fire pump functions, door unlocking and security with bypass capabilities.

j. Devices may be multi-dropped from a single pair of wires. Systems that require factory reprogramming to add or delete devices are not acceptable.

1.2 REFERENCES

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

Section.

B. Related Sections:
1. Division 01 General Requirements
2. Division 07 Thermal and Moisture Protection, Penetration Firestopping
3. Division 08 Openings, Door Hardware
4. Division 21 Fire Suppression
5. Division 23 Heating Ventilating and Air Conditioning Monitoring & Control (HVAC).
6. Division 25 Building Monitoring System

C. Codes, Standards, and References
1. NFPA Codes, Standards and Manuals
a. NFPA 13 (2013) Standard for the Installation of sprinkler systems
b. NFPA 14 (2013) Standard for the Installation of Standpipe and Hose systems
c. NFPA 20 (2013) Standard for the Installation of stationary pumps for fire protection
d. NFPA 70 (2014) National Electrical Code
e. NFPA 72 (2013) National Fire Alarm and Signaling Code
f. NFPA 90A (2014) Air Conditioning & Ventilating Systems
2. Other Codes and Standards
a. ADA (Americans with Disabilities Act)
b. Authority having jurisdiction (AHJ) Building Code including rules and interpretations.
1) International Building Code with AHJ, supplements
2) International Fire Code with AHJ, Supplements
3. Conflicts with Codes
a. If code conflicts with contract documents, code governs.
b. Requirements Exceeding Codes: Where contract document requirements exceed code, provide as indicated and described.

1.3 DEFINITIONS

A. FACP: A facility master control panel having the features of a fire alarm control panel and voice notification control panel interconnected – networked to all sub or remote panels.

B. LCD: Liquid-crystal display

C. LED: Light-emitting diode.

D. Local Operating Console (LOC): A unit designed to allow emergency responders to operate the VNS including delivery or recorded and/or live messages, and textural visible appliance operation and other related functions.

E. NICET: National Institute for Certification in Engineering Technologies.

F. NFPA: National Fire Protection Association. Definitions in NFPA 72 apply to fire alarm terms used in this Section.

G. [VESDA: Very Early Smoke-Detection Apparatus]

1.4 SUBMITTALS

A. Submittal Formats: Submittal shall be delivered in electronic format, PDF files. Each section shall be identified with navigation tabs for ease of review.

B. Specification Compliance: An electronic copy of the specification will be provided to vendors for their responses. Each vendor shall indicate one of the following on every specification requirement paragraph-by-paragraph:
1. Comply - vendor complies or exceeds this requirement.
2. Deviation - vendor deviated from this requirement but provides similar operational and functional capability. Vendor to describe the deviation and how its product meets the specification performance requirement.
3. Non-Compliant - vendor's proposed product does not meet the specification requirement.

C. Product Data:
1. Complete description data including UL listings for each component used
2. System Operation Description: Detailed description for this Project, including method of operation and supervision of each type of circuit and sequence of operations for manually and automatically initiated system inputs and outputs. Manufacturer's standard descriptions for generic systems are not acceptable.

D. Shop Drawings
1. Comply with recommendations and requirements in the "Documentation" section of the "fundamentals" Chapter in NFPA 72.
2. Submit permit shop drawings to the AHJ as defined in NFPA 72. The AHJ for this project is City of San Antonio. Provide the shop drawings with AHJ approval before sending the submittal to the Engineer of Record.
3. System riser diagram with device addresses, conduit sizes, and cable and wire types and sizes.
4. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.
5. Include voltage drop calculations for notification appliance circuits.
6. Include battery size calculations to demonstrate and document adequate battery capacity per specifications.
7. Include input and output matrix.
8. Verify that each Duct detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
9. Plan views indicating equipment and device locations, raceway routes and sizes
10. Duct Smoke Detectors: Performance parameters and installation details for each detector, verifying that each detector is listed for the complete range of air velocity, temperature, and humidity possible when air-handling system is operating. Point-to-point wiring diagrams for all components and interfaces to equipment supplied by others, typical device termination diagrams, wire numbers and colors for all conductors
11. Verify that each detector is listed for complete range of air velocity,

temperature, and humidity possible when air-handling system is operating.

12. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale; coordinate location of duct smoke detectors and access to them.
    a. Show critical dimensions that relate to placement and support of sampling tubes, detector housing and remote status and alarm indicators.
    b. Show field wiring required for HVAC unit showdown on alarm.
    c. Show field wiring and equipment required for HVAC unit shutdown on alarm and override by firefighters control system.
    d. Show filed wiring and equipment required for HVAC unit shutdown on alarm and override by firefighters' smoke-evacuation system.
    e. Locate detectors according to manufacturer's written recommendations.
    f. Show air-sampling detector pipe routing.
13. Ductwork Coordination Drawings: Plans, sections, and elevations of ducts, drawn to scale and coordinating the installation of duct smoke detectors and access to them. Show critical dimensions that relate to placement and support of sampling tubes, the detector housing, and remote status and alarm indicators. Locate detectors according to manufacturer's written recommendations.
14. Voice/Alarm Signaling Service: Equipment rack or console layout, grounding schematic, amplifier power calculation, intelligibility compliance, and single-line connection diagram.
15. Text of all messages on control panel and annunciators, clearly indicate letter size.
16. Complete narrative or matrix of the sequence of operation for all functions.
17. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
18. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits and point-to-point wiring diagrams.

E. General Submittal requirements:
    1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.
    2. Shop Drawings shall be prepared by persons with the following qualifications:
        a. Trained and certified by manufacturer in fire alarm system design.
        b. NICET-Certified, fire-alarm technician; Level III minimum.
        c. Licensed or certified by authorities having jurisdiction.

F. Delegated-Design Submittal: for notification appliances and smoke and heat detectors, in addition to submittals listed above, indicate compliance with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
    1. Drawings showing the location of each notification appliance and smoke and heat detector, ratings of each, and installation details as needed to

comply with listing conditions of the device.

2. Design Calculations: Calculate requirements of selecting and spacing and sensitivity of detection, complying with NFPA 72. Calculate spacing and intensities for strobe signals and sound-pressure levels for audible appliances.
3. Indicate audible appliances required to produce square wave signal per NFPA 72.

G. Informational Submittals
1. Qualification Data; For Certified installer.
2. Seismic Qualification Certificates: for fire-alarm control unit, accessories, and components, from manufacturer.
   a. Basis for Certification: Indicate whether withstand certification is based on
      actual test of assembled components or on calculation.
   b. Dimensioned outline drawings of equipment Unit: Identify center of gravity
      and locate and describe mounting and anchorage provisions.
   c. Detailed description of equipment anchorage devices on which the
      certification is based and their installation requirements.

H. Field quality-control test reports.

I. Closeout Submittals
1. Operation and Maintenance Data: For fire alarm system to include in emergency, operation, and maintenance manuals.
   a. In addition to items specified in Section 017823 "Operation and Maintenance Data" include the following and deliver copies to authorities having jurisdiction.
      1) Comply with the "Records" section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
      2) Provide "Fire Alarm and Emergency Communications System record of Completion documents" Article in the "Documentation" section of the "Fundamentals" Chapter of NFPA 72.
      3) Complete wiring diagrams showing connections between all devices and equipment. Each conductor shall be numbered at every junction point with indication of origination and termination points.
      4) Riser Diagram.
      5) Device Addresses.
      6) Air sampling system sample port locations and modeling and modeling program report showing layout meets performance criteria.
      7) Record copy of site-specific software.
      8) Provide Inspection and Testing Form" according to the "Inspection, Testing, and Maintenance" chapter in NFPA 72, and include the following:
         a) Equipment tested.
         b) Frequency of testing and installed components.
         c) Frequency of inspection of installed components.

d) Frequency of inspection of installed components.
e) Requirements and recommendations related to results of maintenance.
f) Manufacturer's user training manuals.

9) Manufacturer's required maintenance related to system warranty requirements.
10) Abbreviated operating instructions for mounting at fire-alarm control unit and each annunciator unit.

J. Documentation:
1. Approval and Acceptance: Provide the "Record of Completion" form according to NFPA 72 to Owner, Architect, and AHJ.
a. Record of Completion Documents: Provide the "Permanent Records" according to NFPA 72 to Owner, Architect, and AHJ. Format of the written
sequence of operation shall be the optional input/output matrix.
b. Hard copies on paper to Owner.
c. Electronic media may be provided to Architect and AHJ.

2. Software and Firmware Operational Documentation:
a. Software operating and upgrade manuals.
b. Program software backup: On magnetic media or compact disk, complete with data files.
c. Device address list.
d. Printout of software application and graphic screens.

K. Maintenance Material Submittals
1. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
a. Lamps for Remote Indicating Lamp Units: Quantity of 10 percent of amount installed but no fewer than one unit.
b. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but no fewer than one unit.
c. Smoke Detectors, Fire Detectors, and Flame Detectors: Quantity equal to 10 percent of amount of each type installed, but no fewer than one unit of each type.
d. Detector bases: Quantity equal to two percent of amount of each type installed, but no fewer than one unit of each type.
e. Keys and Tools: One extra set of for access to locked or tamper proofed components.
f. Fuses: Two of each type installed in the system. Provide in a box or cabinet with compartments marked with fuse types and sizes.
g. Filters for Air-Sampling Detectors: Quantity equal to two percent of amount of each type installed, but no fewer than one unit of each type.
h. Air-sampling Fan: Quantity equal to one for every five detectors, but no fewer than one unit of each type.

1.5 QUALITY ASSURANCE

A. Performance Requirements:
1. General Performance: Comply with NFPA 72 and all contract documents

and specification requirements.

2. System shall be a complete, supervised, non-coded, intelligent fire alarm system conforming to NFPA 72.
3. The system shall provide the following functions and operating features:
   a. The FACP and auxiliary panels shall provide power, annunciation, supervision, and control for the system.
   b. Provide Class B signaling line circuits for the network.
   c. Provide Class B notification appliance circuits.
   d. Strobes shall be synchronized throughout the entire building.
   e. The voice evacuation system amplifiers shall be configured as distributed, bulk, or a combination of distributed and bulk audio. Provide capability for up to 8 channels for live and recorded voice messaging.
   f. Provide electrical supervision of the primary power (AC) supply, presence of the battery, battery voltage, and placement of system modules within the control panel.
4. The system shall provide a field test function where one person can test the complete system or a specific area while maintaining full operational function of other areas not being tested. Alarms, supervisory signals, trouble signals shall be logged on the system printer and in system history during the walk-test.
5. Alarm functions shall override trouble or supervisory functions. Supervisory functions shall override trouble functions.
6. When identified by a risk analysis or emergency response plan, voice communication message shall take priority over fire alarm messages and signals.
7. After the voice communication relinquishes control, resumption of the previously initiated fire alarm signals and subsequent fire alarm signals shall require manual intervention.
8. Fire alarm signal initiation shall be by one or more of the following devices:
   a. Manual pull stations.
   b. Heat detectors.
   c. Flame detectors.
   d. Smoke detectors
   e. Duct smoke detectors
   f. Air-sampling smoke detection system (VESDA)
   g. Carbon monoxide detectors.
   h. Combustible gas detectors.
   i. Automatic sprinkler system water flow switch.
   j. Preaction system.
   k. Fire-extinguishing system operation.
   l. Fire Standpipe Systems.
   m. Dry system pressure flow switch
   n. Activation of kitchen hood extinguishing system.
   o. Fire Pump running.
9. Activation of any system fire, security, supervisory, trouble, or status initiating device shall cause the following actions and indications at all network nodes using basic graphics and multiple detail screens.
   a. Fire Alarm Condition:
      1) Continuously operate alarm notification appliances, including voice evacuation notices.
      2) Identify alarm and specific initiating device at fire alarm

control unit, connected network control panels, off premises network control panels and remote annunciators.

3) Transmit an alarm signal to the remote alarm receiving station. (Two dedicated telephone lines, service, and connection by owner and/or approved radio transmission).
4) Unlock electric door locks in designated egress paths.
5) Release fire and smoke doors held open by magnetic door holders.
6) Activate voice/alarm communication system.
7) Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
8) Active smoke-control system (smoke management) at firefighter's smoke-control system panel.
9) [Activate stairwell and elevator shaft pressurization systems.]
10) Close smoke dampers in air ducts of designated air-conditioning duct systems.
11) [Activate preaction system]
12) Recall elevators to primary or alternate floor recalls.
13) Activate elevator power shunt trip.
14) Activate emergency lighting control.
15) Activate emergency shutoffs for gas and fuel supplies.
16) [Record events by the system printer.]
17) [Indicate device in alarm on the graphic annunciator.]
18) Sound an audible alarm at the panel and display a custom screen/message defining the building in alarm and the specific alarm point initiating the alarm.
19) Sound an alert tone, followed by an approved custom voice evacuation message with synchronized strobes. Visual signals shall be programmed to follow the state of the audible signals.
20) System operated duct detectors as per local requirements shall accomplish HVAC shut down.
21) Signal the building access control system.
22) Signal the Building Management System (BMS).

b. Additional system operation for the Fire Alarm Condition for Voice:

1) An automatic announcement or tone evacuation signal shall be capable of interruption by the operation of the system microphone to give voice evacuation instructions overriding the pre-programmed sequences.
2) Status lights next to speaker selection switches on the control panel shall indicate speaker circuit selection.
3) When using the microphone, live messages shall be broadcast throughout the building. The system shall be capable of operating all speakers at the same time. The microprocessor shall actively interrogate circuitry, field wiring, and digital coding necessary for the immediate and accurate rebroadcasting of the stored voice data into the appropriate amplifier input. Loss of operating

power, supervisory power, or any other malfunction that could render the digitalized voice module inoperative shall automatically cause the code 3 temporal tone to take over all functions assigned to the failed unit in the event an alarm is activated.

4) The Voice Notification functions shall be manual or automatic fire alarm notification(s) or emergency notification functions. Other fire alarm functions including transmission of a signal(s) to the fire department shall remain operational. Notification Appliance Circuits (NAC) shall be provided for the activation of strobe appliances. The activation of the NAC Circuits shall follow the operation of the speaker NAC circuits. Audio output shall be selectable for line level. Amplifier outputs shall be not greater than 100watts RMS output. The strobe NAC Circuits shall provide at least 2 amps of 24 VDC power to operate strobes and have the ability to synchronize all strobes. A handheld microphone shall be provided and, upon activation, shall take priority over any tone signal, recorded message or PA microphone operation in progress, while maintaining the strobe NAC Circuits activation.

c. Supervisory signal initiation shall be by one or more of the following devices and actions:
   1) Valve supervisory switch
   2) High or low-air-pressure switch of a dry-pipe or preaction sprinkler system.
   3) Alert and action signals of air-sampling detector system.
   4) Elevator shunt-trip supervision.
   5) Fire Pump Running.
   6) Fire-Pump loss of power.
   7) Fire-Pump power phase reversal.
   8) Independent fire-detection and suppression system.
   9) User disabling of zones or individual devices.
   10) Loss of communication of any panel on the network.
   11) Respective Duct mounted smoke detection device.
   12) Off normal conditions of the Fire Protection Systems.

d. System trouble signal initiation shall be by one or more of the following devices and actions:
   1) Open circuits, shorts, and grounds in designated circuits.
   2) Opening, tampering with, or removing alarm-initiating and supervisory signal- initiating devices.
   3) Loss of communication with any addressable sensor, input module, relay, control module, remote annunciator, printer interface, or Ethernet module.
   4) Loss of primary power at fire alarm control unit.
   5) Ground fault or a single break in fire alarm control unit internal circuits.
   6) Break in standby battery circuitry.
   7) Failure of battery charging
   8) Abnormal position of any switch at fire alarm control unit or annunciator.

9) Voice signal amplifier failure.
10) Hose cabinet door open.

e. System supervisory Signal Actions:
1) Initiate notification appliances.
2) Identify specific device initiating the event at fire-alarm control unit, connected network control panels, off-premises network control panels, and remote annunciators.
3) Record the event on system printer.
4) After a time delay of 200 seconds, transmit a trouble or supervisory signal to the remote alarm receiving station.
5) Transmit system status to building management system.
6) Display system status on graphic annunciator.

B. Supplier Qualifications
1. Provide the services of a factory trained and certified representative or technician, experienced in the installation and operation of the type of system provided. The representative shall be licensed in the State if required by law.
2. The technician shall supervise installation, software documentation, adjustment, preliminary testing, final testing, and certification of the system. The technician shall provide the required instruction to the owner's personnel in the system operation and maintenance.
3. The supplies shall furnish evidence they have an experienced service organization, which carries a stock of spare and repair parts for the system being furnished.
4. The equipment supplier shall be authorized and trained by the manufacturer to calculate, design, install, test and maintain the air sampling system and shall be able to produce a certificate stating such upon request.

C. Installer Qualifications
1. The contractor shall submit copies of all required Licenses and Bonds as required in the State having jurisdiction.
2. The contractor shall employ on staff a minimum of one NICET level III technician or a professional engineer, registered in the State of Texas for the installation.
3. Personnel shall be trained and certified by manufacturer for installation of units required for this Project.
4. NFPA Certification: Obtain certification according to NFPA 72 by a UL-Listed Alarm company.
5. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this project.
6. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level III technician.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to AHJ, and marked for intended use.

E. System installed in compliance with NFPA 72

F. UL listed under the appropriate UL standard for fire alarm applications; comply with UL 864 transient protection requirements.

G. All components and assemblies shall be UL listed and approved by the AHJ for use.

H. Software and system service agreement:
1. Comply with UL 864.
2. Technical Support: Beginning with Substantial Completion, provide software support for two years.
3. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.
   a. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.
4. Response for system repair and maintenance by qualified NICET technicians, (minimum Level II Fire Alarm Technology) to the job site within four (4) hours of request, 24 hours a day 7 days a week.

1.6 COORDINATION

A. Coordinate with HVAC equipment for type and location of smoke detection devices.

B. Fire Protection Contractor:
1. The Fire Alarm Contractor shall coordinate with the Fire Protection contractor to facilitate installation of the Fire Protection Systems for the approved Project Schedule.

C. Building Fire Alarm system shall monitor kitchen fire suppression systems.

1.7 DELIVERY, STORAGE AND HANDLING

A. The Fire Alarm Contractor shall be responsible to coordinate with client and construction administrator to ensure delivery schedule is in compliance with Project requirements of logistics and coordinated delivery, storage and handling of equipment, parts and materials.

1.8 PROJECT CONDITIONS

A. The Project Schedule may require work to be performed after normal work hours.
1. Perform a full test of the existing system prior to starting work. Document any equipment or components not functioning as designed.
2. Interruption of Existing Fire Alarm Service: Do not interrupt fire-alarm service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary guard service according to the requirements indicated:
   a. Notify owner no fewer than seven days in advance of proposed

interruption of fire-alarm service.

b. Do not proceed with interruption of fire-alarm service without written permission.

3. Use of devices during Construction: Protect devices during construction unless devices are placed in service to protect the facility during construction.

1.9 SEQUENCING AND SCHEDULING

A. Existing Fire-Alarm Equipment: Maintain existing equipment fully operational until new equipment has been tested and accepted. As new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels form new equipment when put into service, and label existing fire-alarm equipment "NOT IN SERVICE" until removed from the building.

B. Equipment Removal: After acceptance of new fire-alarm system, remove existing disconnected fire alarm equipment and wiring.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire alarm equipment that fail(s) in materials or workmanship within specified warranty period.

1. Warranty Extent: All equipment and components not covered in the Maintenance Service Agreement.
2. Warranty Period: Five Years from date of Substantial Completion.
3. A copy of the manufacturer's warranty shall be provided with closeout documentation and included with the operation and installation manuals. The full cost of maintenance, labor and materials required to correct any defect during the warranty period shall be included in the submittal bid.
4. During the warranty period, each year the contractor shall perform detector sensitivity testing and provide a report to the owner. If the system is UL Listed to perform automatic detector sensitivity testing without manual intervention, and if a detector falls outside of sensitivity window the system automatically indicates a devices trouble, then this requirement shall be waived. Documentation from UL shall be provided as proof of automatic sensitivity testing operation.
5. The system supplier shall maintain a service organization with adequate spare parts stock. Provide a telephone response to owner's questions within 4 hours and on-site assistance within 24 hours.
6. Permit the owner's fire alarm technicians to perform temporary bypasses and emergency repairs on the system without voiding the warranty.

1.11 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. Lamps
   a. Remote Indicating Lamp Units - Quantity equal to 10 percent of amount installed, but not less than 1 unit. LED lamps are preferred and will not require spare lamps.

b. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but not less than 3 units of each type.

2. Detectors and Initiating Devices: Provide the following installed and ready for operation including raceway, conductor, termination, software programming, startup, testing, commissioning, and O&M documentation.
3. Detector Bases: Quantity equal to 2 percent of amount of each type installed, but not less than 1 unit of each type.
4. Keys and Tools: One extra set for access to locked and tamperproof components.
5. Audible and Visual Notification Appliances: One of each type installed.
6. Fuses: Three of each type installed in the system.
7. Furnish the following additional devices including installation and 50 feet of raceway and conductor. Install in location as directed wiring to connect, software programming, startup, testing, commissioning, O&M, record drawing revision and training to fully incorporate into the project at locations to be identified by the Owner and/or Fire Marshall. Units not installed at completion of contract shall be turned over to Owner to utilize as spares. Raceway and conductors are not required to be turned over if devices are not installed:
   a. Pull Station (Red) – Quantity of four (4)
   b. Ceiling Mounted Speaker/Strobe – Quantity of six (6)
   c. Wall Mounted Speaker Strobe - Quantity of ten (10)
   d. Wall Mounted Audible - Quantity of six (6)
   e. Heat Detector - Quantity of four (4)
   f. Detector Bases - Quantity of four (4)
   g. NAC panel – Quantity of one (1)
   h. Transponder panel – Quantity of one (1)
8. Miscellaneous Devices
   a. Keys and Tools for Access to Locked and Tamperproof components - Quantity of six (6)
   b. Fuses - Quantity Three (3) of each type installed in the system

1.12 FACTORY WITNESS TESTING

A. Not required

1.13 COMMISSIONING TESTING

A. The contractor shall have a manufacturer's representative attend commissioning of the entire installation in the presence of the owner and/or its representative.

B. All necessary instrumentation, equipment, materials, and labor shall be provided by the Contractor.

C. The Contractor shall record all tests and system calibrations and a copy of these results shall be retained on site in the System Log Book.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with specification requirements. Products shall be provided by the following manufacturer exclusively:

1. Tyco-Simplex Grinnell

2.2 FIRE ALARM CONTROL PANEL

A. Source limitations for Fire-Alarm System and Components: Components shall be compatible with and operate as an extension of existing system. Provide system manufacturer's certification that all components provided have been tested as, and will operate as, a system.

B. Noncoded, UL-Certified addressable system, with multiplexed signal transmission and voice/horn/strobe evacuation.

C. Automatic sensitivity control of certain smoke detectors.

D. All components provided shall be listed for use with the selected system.

E. Electrical components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. The main fire alarm control panel shall be Tyco Simplex Grinnell 4100ES (or approved equal). The system shall be a complete, electrically supervised fire detection and notification system, with a microprocessor-based operating system having the following capabilities, features, and capacities:
   1. The system shall support multiple loops of addressable devices, each of which may be divided in any ratio on one, two, three, or four separate, isolated Class B circuits.
   2. Support of mobile test system capable of providing point test reports in NFPA standard format without manual report entries.
   3. System shall provide an output port for monitoring purposes by external systems. Communications to an external system shall be RS-232 or RS-485 communications.
   4. All fire alarm control panels shall support an Ethernet connection.
   5. Digital communication capabilities supporting Class X communications using DC digital technologies as required for the control panel to communicate with other nodes
   6. Capability shall exist within the system to extend the network at any node. The system shall support a maximum of two network extension circuits in series on any system branch, extending the inherent distance limitations for network communications. Communication protocol shall be of the RS485 type.

G. Performance Requirements
   1. Seismic Performance: Fire-Alarm control unit and raceways shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

a. System software and programs shall be held in nonvolatile flash, electrically erasable, programmable, read-only memory, retaining the information through failure of primary and secondary power supplies.
b. Include a real-time clock for time annotation of events on the event recorder and printer.
c. Provide communication between the fire-alarm control unit and remote circuit interface panels, annunciators, and displays.
d. The fire-alarm control unit shall be listed for connection to a central-station signaling system service.
e. Provide nonvolatile memory for system database, logic, and operating system and event history. The system shall require no manual input to initialize in the event of complete power down condition. The fire-alarm control unit shall provide a minimum 500-event history log.

2. Addressable Initiation Device Circuits: The fire-alarm control unit shall indicate which communication zones have been silenced and shall provide selective silencing of alarm notification appliance by building communication zone.
3. Addressable Control circuits for Operation of Notification Appliances and Mechanical Equipment: The fire-alarm control unit shall be listed for releasing service.

H. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.
1. Annunciator and Display: Liquid-crystal type, 80 characters minimum.
2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.

I. Initiating Device, Notification -Appliance, and Signaling-Line Circuits:
1. Pathway Class Designations: NFPA 72, Class A, Class B, Class C, Class D, Class E.
2. Pathway Survivability: Level 1.
3. Serial Interfaces:
a. One dedicated RS 485 port for central-station operation using point ID DACT.
b. One RS 485 port for remote annunciators, Ethernet module, or multi-interface module (printer port).
c. One USB port for PC configuration.
d. One RS 232 port for VESDA HLI connection.
e. One RS 232 port for voice evacuation interface.

J. Stairwell and Elevator Shaft Pressurization; Provide an output signal using an addressable relay to start the stairwell and elevator shaft pressurization system. Signal shall remain on until alarm conditions are cleared, and fire-alarm system is reset. Signal shall not stop in response to alarm acknowledge or signal silence commands.

1. Pressurization starts when any alarm is received at fire-alarm control unit.
2. Alarm signals form smoke detectors at pressurization air supplies have a higher priority than other alarm signals that start the system.

K. Smoke Alarm Verification:
1. Initiate audible and visible indication of an "alarm verification" sequence at fire-alarm control unit and detector.
2. [Record events by the system printer.]
3. Sound general alarm if the alarm is verified.
4. Cancel fire-alarm control unit indication and system reset if the alarm is not verified.

L. Notification Appliance Circuit:
1. Audible appliances shall sound in a three-pulse temporal pattern, as defined in NFPA 72.
2. Where notification appliances provide signals to sleeping areas, the alarm signal shall be a 520-Hz square wave with an intensity 15 dB above the average ambient sound level or 5 dB above the maximum sound level, or at least 75 dBA, whichever is greater, measured at the pillow.
3. Visual Alarm appliances shall flash in synchronization where multiple appliances are in the same field of view, as defined in NFPA 72.

M. Elevator Recall:
1. Elevator recall shall be initiated only by one of the following alarm-initiating devices:
   a. Elevator lobby detectors except the lobby detector on the designated floor.
   b. Smoke detector in elevator machine room.
   c. Smoke detectors in elevator hoistway.
2. Elevator controller shall be programmed to move the cars to the alternate recall floor if lobby detectors located on the designated recall floors are activated.
3. Water-flow alarm connected to sprinkler in an elevator shaft and elevator machine room shall shut down elevators associated with the locations without time delay.
   a. Water-flow switch associated with the sprinkler in the elevator pit may have a delay to allow elevators to move to the designated floor.

N. Door Controls
1. Door-hold open devices that are controlled by smoke detectors at doors in smoke-barrier walls shall be connected to the Fire-Alarm system.

O. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their status, and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory and print out the final adjusted values on system printer.

P. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.

Q. Voice/Alarm Signaling Service: Central emergency communication system with redundant microphones, preamplifiers, amplifiers, and tone generators provided

as a special module that is part of fire-alarm control unit.

1. Indicate number of alarm channels for automatic, simultaneous transmission of different announcements to different zones for manual transmission of announcements to different zones or for manual transmission of announcements by use of the central-control microphone. Amplifiers shall comply with UL 1711.
   a. Allow the application of, and evacuation signal to, indicated number of zones and, at the same time, allow voice paging to the other zones selectivity or in any combination.
   b. Programmable tone and message sequence selection.
   c. Standard digitally recorded messages for "Evacuation" and "All Clear".
   d. Generate tones to be sequenced with audio messages of type recommended by NFPA 72 and that are compatible with tone patterns of notification appliance circuits of fire-alarm control unit.
2. Status Annunciator: Indicate the status of various voice/alarm speaker zones and the status of firefighter's two-way telephone communication zones.
3. Preamplifiers, amplifiers, and tone generators shall automatically transfer to backup units.

R. Printout of Events: On receipt of signal, print alarm, supervisory, and trouble events. Identify zone, device, and function. Include type of signal (alarm, supervisory, or trouble) and date and time of occurrence. Differentiate alarm signals form all other printed indications. Also print system reset event, including same information for device, location, date, and time. Commands initiate the printing of a list of existing alarm, supervisory, and trouble conditions in the system and a historical log of events.

S. Primary Power: 24-V dc obtained from 120-V ac service and a power supply module. Initiating devices, notification appliances, signaling lines, trouble signals supervisory signals, supervisory and digital alarm communicator transmitters and digital alarm radio transmitters shall be powered by 24-V dc source.
   1. Alarm current draw of entire system shall not exceed 80 percent of the power-supply module rating.

T. Secondary power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.

U. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

V. Preaction System:
   1. Initiate Pre-signal alarm: This function shall cause and audible and visual alarm indication to be provided at the FACP. Activation of an initiation device connected as a part of a preaction system shall be annunciated at the FACP only, without activation of the general evacuation alarm.

W. System Components:
   1. The signal line circuits shall be tested for opens, shorts and

communications with all intelligent devices installed before connection to the control panel. Systems without this capability shall have a test panel installed for initial testing to eliminate any possible damage short term or long term to the control panel. After initial testing replace the test panel and proceed with complete testing.

2. The Alphanumeric Display and System Controls shall be arranged for interface between human operator at the FACP and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.
3. The system display shall consist of an LCD display that has three line(s) of 80 characters, minimum.
4. Keypad: Arranged to permit entry and execution of programming, display, and control commands; and to indicate control commands to be entered into the system for control of smoke-detector sensitivity and other parameters.
5. The remote printer module shall provide a means for connecting the FACP system to a printer for creating a hard copy of system status and configuration reports. The printer module shall also provide a foreign system interface output port that can be configured to communicate with external systems, such as building management systems.

X. Passwords:

1. Technician Level Password - There shall be a 5-character password that a user must enter the control panel in order to perform such maintenance- and control-related functions at the panel as:
   a. Arming and disarming devices.
   b. Activating, deactivating, or modifying detector ASD and sensitivity settings.
   c. Activating and deactivating the History Log function and deleting obsolete entries.
   d. Changing the system time and date.
2. Maintenance Level Password - There shall be a 5-character password that a user must enter into the control panel in order to access the panel's reporting functions and walk-test functions

Y. Software Modifications: The system structure and software shall place no limit on the type or extent of software modifications on-site. Modification of software shall not require power-down of the system or loss of system fire protection while modifications are being made. Systems that require the use of external programmers or change of EPROMs are not acceptable.

Z. Logic: The fire alarm system shall support generic functions that deal with binary states (True/False, high/low), and produce desired outputs from one or more binary inputs (for example, alarm outputs from detector or manual station inputs). AND, OR, NOT, Any N, Latches, Start Timer, Delay Timer, Restart Timer are generic functions. Generic functions can be used as inputs to other function.

AA. History: The system shall store 20,000 events in history. Trouble warnings will occur when the History buffer is full.

BB. Walk Test Mode: The system shall provide a field test function where one person

can test the complete system or a specific area while maintaining full operational function of other areas not being tested. Alarms, supervisory signals, trouble signals shall be logged on the system printer and in system history during the walk-test.

CC. Field Programming: The system shall be capable of being configured either at the control panel or via a PC Tool. All programs shall be stored in non-volatile EEPROM memory. Programming shall be accomplished only after entering an appropriate password security code. The system shall be capable of revising/changing programmed functions or system expansion at any time subsequent to initialization as described herein without factory modifications or factory programming.

DD. Instructions: Computer printout or typewritten instruction card mounted in a frame behind a plastic or glass cover. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

EE. Networking:

1. Digital communication capabilities supporting Class B or Class X communications using either DC digital or fiber optics technologies or combinations of both as required for the control panel to communicate with up to 4 network nodes.
2. Capability shall exist within the system to extend the network at any node. The system shall support a maximum of two network extension circuits in series on any system branch, extending the inherent distance limitations for network communications.
3. Communication protocol shall be of the RS485 type.
4. The network configuration shall provide internode communication between enclosures, including all remote annunciators. Communication shall be Class X wiring (in a ring configuration).
5. Communications between network nodes, each supporting an interactive, self-standing, intelligent local control panel, with system wide display. Any network node shall be capable of supporting a local system with the same capacities and features specified herein.
6. In networked systems, each control panel shall be a global annunciator, capable of viewing all other control panels on the network.

FF. Degrade Mode Alarm Activation:

1. Each panel shall operate as a stand-alone fire alarm control panel with complete functionality in the event of loss of communications with other panels on a network.

GG. Spare Capacity

1. Initiating Devices Circuits: Minimum 25 percent spare Capacity
2. Notification Appliance Circuits: Minimum 25 percent spare Capacity
3. Speaker Amplifier: Minimum 25 percent spare Capacity
4. Master Control Unit: Capable of handling all circuits utilized to capacity withoutrequiring additional components other than plug-in control modules.

2.2 FIRE SAFETY SYSTEMS INTERFACES

A. Supervision: Provide supervisory signals in accordance with NFPA 72 for the following:
   1. Sprinkler water control valves.
   2. Elevator shut-down control circuits.
   3. Fire smoke damper

B. Control
   1. Exhaust fans
   2. Fire smoke damper
   3. Fire Shutters/Won-Doors

2.2 SYSTEM ENCLOSURE

A. Transparent door panel(s) providing protection from tampering and allowing full view of the visual indicators and controls

B. The enclosure shall be identified by an engraved laminated phenolic resin nameplate. Lettering on the nameplate shall say "Fire Alarm Control Panel" with the FACP designation "Main Panel" and shall not be less than 25 mm 1 inch high and identifying Remote FACP or "Sub Panel XX-X" (X designating the number assignment for Remote FACP's of the networked system).

2.3 INTELLIGENT INITIATING DEVICES

A. Intelligent Initiation Devices
   1. All initiation devices shall be insensitive to initiating loop polarity. Specifically, the devices shall be insensitive to plus/minus voltage connections on either Class B or Class A circuits.

B. General requirements for System Smoke Detectors:
   1. Comply with UL 268 operating at 24-V dc, nominal.
   2. Integral Addressable module: Arranged to communicate detector status (normal, alarm or trouble) to fire-alarm control unit.
   3. Base mounting: Detector and associated electronic components shall be mounted in a twistlock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
   4. Self-restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
   5. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-status.
   6. Remote Control: Unless otherwise indicated, detectors shall be digital-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit
      a. Rate-of-rise temperature characteristic of combination smoke and heat detection units shall be selectable at fire-alarm control unit for 15 or 20 degree per minute.
      b. Fixed-temperature sensing characteristic of combination smoke and heat detection units shall be independent of rate-of-rise sensing and shall be settable at fire-alarm control unit to operate

at 135 or 155 deg. F.
c. Multiple levels of detection sensitivity for each sensor.
d. Sensitivity levels based on time of day.

C. Photoelectric Smoke Detectors
1. General requirements for the system smoke detectors:
a. Non polarized, 24VDC, solid state photoelectric type operating on the light scattering, photodiode principle
b. Shall communicate actual smoke chamber values to the Control Panel. Adjustable sensitivity of the detector from the control panel shall be possible with a sensitivity range from .5% to 3.7% in .5% increments. The alarm decision for each sensor shall be determined by the control panel. The control panel shall determine the condition of each sensor by comparing the sensor value to the stored values
c. The control panel shall maintain a moving average of the sensors' smoke chamber value to automatically compensate (move the threshold) for dust and dirty conditions that could affect detection operations. The system shall automatically maintain constant smoke obscuration sensitivity for each sensor (via the floating threshold) by compensating for environmental factors. A dirty trouble condition shall be reported any time the average value of a detector reaches a preset value. Additionally, the LED on the sensor base shall glow steady giving a visible indication at the sensor location. If a "DIRTY SENSOR" is left unattended, and its average value increases to a second predetermined value, an "EXCESSIVELY DIRTY SENSOR" trouble condition shall be indicated at the control panel for the individual sensor.
d. UL Listed
e. 0 to 2000 feet per minute air flow
2. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location with the system in its sensitivity setting.
3. An Operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector.
a. Primary status.
b. Device type.
c. Present average value.
d. Present sensitivity.
e. Sensor range (normal, dirty, etc)
4. UL 268A listed, operating at 24-V dc, nominal.
5. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.
6. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. The fixed base shall be designed for mounting directly to the air duct. Provide terminals in the fixed base for connection to building wiring.
a. Weatherproof Duct Housing Enclosure: UL listed for use with the supplied detector. The enclosure shall comply with NEMA 250 requirements for Type 4X.
7. Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.

8. Integral Visual-Indicating Light: LED type. Indicating detector has operated and power-on status. Provide remote status and alarm indicator and test station where indicated.
9. Each sensor shall have multiple levels of detection sensitivity.
10. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit. Relay shall be integrated to the either the base or head on all duct detectors.

D. Ionization Smoke Detector:
1. Detector address shall be accessible form fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity rating.
2. An Operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
   a. Primary status.
   b. Device type.
   c. Present Average value.
   d. Present sensitivity selected.
   e. Sensor range (normal, dirty, etc).

E. Air Duct Smoke Detectors:
1. Conform to NFPA 90A Chapter 4 "Controls". Provide duct smoke detector(s) in the supply and return air streams in each system in accordance with the International Mechanical Code (IMC) and local amendments. Coordinate installation with Division 23 and sheet metal installer. Provide all relays and wiring of fan shutdown circuits to all required motor starter control circuits. These circuits are not shown on the drawings.
2. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
3. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
   a. Primary Status.
   b. Device type.
   c. Present Average value.
   d. Present sensitivity selected.
   e. Sensor range (normal, dirty, etc.).
4. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL Listed for use with the supplied detector for smoke detection in HVAC system ducts.
5. Each Sensor shall have multiple levels of detection sensitivity.
6. Relay Fan Shutdown: Fully programmable relay rated to interrupt fan motor-control circuit.

F. Heat Detectors:
1. General requirements for Heat Detectors: UL 521 listed.
   a. Temperature sensors shall test for and communicate the sensitivity range of the device.
2. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg. or rated of rise that exceeds 215 deg F per minute unless otherwise indicated.
   a. Mounting: Twist-lock base, interchangeable with smoke-detector bases.
   b. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the fire-alarm

control unit.

3. Signals to the Central FACP: Any type of local system trouble is reported to the central FACP as a composite "alarm" signal.
4. Heat Detector, Fixed-temperature Type: Actuated by temperature that exceeds a fixed temperature 135 deg. Sensing shall be independent of rate-of-rise sensing and shall be settable at the fire-alarm control unit to operate at 135 degrees F. except for Boiler and Generator rooms where temperature shall be 220°F.
   a. Mounting: Twist-lock base interchangeable with smoke-detector bases.
   b. Integral Addressable Module: Arranged to communicate detector status (normal, alarm or trouble) to fire-alarm control unit.

G. Projected Beam Smoke detectors
1. Projected Beam Light Source and Receiver: Designed to accommodate small angular movements and continue to operate and not cause nuisance alarms.
2. Detector address: Accessible from fire-alarm control unit and able to identify the detector's location within the system and its sensitivity setting.
3. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector.
   a. Primary status.
   b. Device type.
   c. Present average value.
   d. Present sensitivity selected.
   e. Sensor range (normal, dirty, etc.)

H. Carbon Monoxide Detectors
1. General: Carbon Monoxide detector listed for connection to fire-alarm systems.
   a. Mounting: Adapter plate for outlet box mounting.
   b. Testable by introducing test carbon monoxide into the sensing cell.
   c. Detector shall provide alarm contacts and trouble contacts.
   d. Detector shall send trouble alarm when nearing the end-of-life, power supply problems or internal faults.
   e. Comply with UL 2075.
   f. Locate, mount, and wire according to manufacturer's written instructions.
   g. Provide means for addressable connection to fire-alarm system.
   h. Test button simulates an alarm condition.

I. Continuous Linear Heat-Detector System:
1. Detector Cable: Rated detection temperature 155 deg. F. Listed for regular service and a standard environment. Cable includes two steel actuator wires twisted together with spring pressure, wrapped with protective tape, and finished with PVC outer sheath. Each actuator wire is insulated with heat-sensitive material that reacts with heat to allow the cable twist pressure to short circuit wires at the location of elevated temperature.
2. Control Unit: Two-zone or multizone unit as indicated. Provide same system power supply, supervision, and alarm features as specified for fire-alarm control unit.
3. Signals to Fire-Alarm Control unit: Any type of local system trouble shall be reported to fire-alarm control unit as a composite "trouble" signal. Alarms

on each detection zone shall be individually reported to central fire-alarm control unit as separately identified zones.

4. Integral Addressable Module: Arranged to communicate detector status (normal, alarm or trouble) to fire-alarm control unit.

J. Air Sampling Smoke Detector
   1. General Description:
      a. Air sampling smoke detector shall be laser based using a piping system and a fan to transport the particles of combustion to the detector.
      b. Provide two levels of alarm from each zone covered by the detector and two supervisory levels of alarm from each detector.
      c. The air being sampled shall pass through filters to remove dust particles greater than 20 microns before entering the detection chamber.
      d. Detectors shall communicate with the fire-alarm control unit via addressable, monitored dry contact closures. RS 485, and interface modules. Provide a minimum of six relays, individually programmable remotely for any function.
      e. Pipe airflow balancing calculations shall be performed using approved calculation software.

K. Multicriteria Detectors
   1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
   2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm or trouble) to fire-alarm control unit.
   3. Automatically adjusts it sensitivity by means of drift compensation and smoothing algorithms. The detector shall send trouble alarm if its incapable of compensating for existing conditions.
   4. Test button tests all sensors in detectors.
   5. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector.
      a. Primary status.
      b. Device type.
      c. Present sensitivity selected.
      d. Sensor range (normal, dirty, etc.)
   6. Sensors: The detector shall be comprised of four sensing elements including a smoke sensor, a carbon monoxide sensor, an infrared sensor, and a heat sensor.
      a. Smoke sensor shall be photelectric type as described in "system Smoke Detectors" Article.
      b. Carbon Monoxide Sensor shall be as described in "Carbon Monoxide Detectors" Article.
      c. Heat Sensor shall be as described in "Heat Detectors" Article.
      d. Each Sensor shall be separately listed according to requirements for its detector type.

L. Detector:
   1. Detector, Filter, Aspirator, and Relays: Housed in a mounting box and arranged in such a way that air is drawn from the detection area and a sample passed though the dual-stage filter and detector by the aspirator.
   2. Obscuration Sensitivity Range: 0.005 – 6 percent obs/ft.
   3. Four independent, field programmable, smoke-alarm thresholds per sensor pipe and a programmable scan time delay. The threshold set points shall be programmable.

a. The four alarm thresholds may be used as follows:
   1) Alarm Level 1 (Alert): Activate a visual and an audible supervisory alarm.
   2) Alarm Level 2 (Action): Activate shutdown of electrical/HVAC equipment and activate a visual and an audible supervisory alarm.
   3) Alarm Level 3 (Fire 1): Activate building alarm systems and initiate call to fire response unit.
   4) Alarm Level 4 (Fire 2): Activate suppression system or other countermeasures.
b. Final Detection System Settings: Approved by Owner.
c. Initial Detection Alarm Settings:
   1) Alarm Level 1 (Alert): 0.08 Percent obs/ft.
   2) Alarm Level 2 (Alert): 1.0 Percent obs/ft.
   3) Alarm Level 3 (Alert): 2.0 Percent obs/ft.
   4) Alarm Level 4 (Alert): 4.0 Percent obs/ft.

4. Power Supply:
   a. Regulated 24-V dc, monitored by the fire-alarm control unit, with battery backup.
   b. Battery backup shall provide 24 hours standby, followed by 30 minutes at maximum connected load.
5. Detector shall transmit the following faults:
   a. Detector.
   b. Airflow.
   c. Filter.
   d. System.
   e. Zone.
   f. Network.
   g. Power.
6. Provide four in-line sample pipe inlets that shall contain a flow sensor or each pipe inlet. The detector shall be capable of identifying the pipe from which smoke was detected.
7. Aspirator: Air pump capable of allowing for multiple sampling pipe runs up to 650 feet in total, (four pipe runs per detector) with a transport time of less than 120 seconds from the farthest sample port.
8. Air Sampling Flow Rates Outside Manufacturer's Specified Range: Result in a trouble alarm.
9. Provide software- programmable relays rated at 2A at 30-V dc for alarm and fault conditions.
10. Provide built-in event and smoke logging: store smoke levels, alarm conditions, operator actions, and faults with date and time of each event. Each detector (zone) shall be capable of storing up to 18,000 events.
11. Urgent and Minor Faults. Minor faults shall be designated as trouble alarms, Urgent faults, which indicate the unit may not be able to detect smoke, shall be designated as supervisory alarms.

M. Displays:
1. Include display module within each detector.
2. Each display shall provide the following features at a minimum:
   a. A bar-graph display.
   b. Four Independent, high intensity alarm indicators (Alert, Action, Fire 1, and Fire 2, corresponding to the four alarm thresholds of the indicated sector.
   c. Alarm threshold indicators for Alert, Action and Fire 1.
   d. LED indication that the first alarm sector is established.
   e. Detector fault and airflow fault indicators.

f. LED indicators shall be provided for faults originating in the particular zone (Zone Fault), faults produced by the overall smoke-detection system, and faults resulting from network wiring errors (Network Fault).
g. Minor and urgent LED fault indicators.

N. Sampling Tubes:
1. Smooth bore with a nominal 1-inch OD and a 7/8-inch ID. Sampling pipe with between 5/8-and 1-inch ID can be used specifically approved locations when recommended by manufacturer.
2. Pipe Material: CPVC and complying with UL 1887, "Safety Fire Test of Plastic Sprinkler Pipe for Visible Flame and Smoke Characteristics".
3. Joints in the sampling pipe shall be airtight. Use solvent cement approved by the pipe manufacturer on all joints except at entry to the detector.
4. Identify piping with labels reading: "Aspirating Smoke Detector Pipe – Do not Paint or Disturb" along its entire length at intervals according to NPFA 72.
5. Support pipes at not more than 60-inch centers.
6. Fit end of each trunk or branch pipe with an end cap and drilled with a hole appropriately sized to achieve the performance as specified and as calculated by the system design.

O. Sampling Holes:
1. Sampling holes of 5/64 inch, or other sized holes per manufacturer's written instructions, shall be separated by not more than the maximum distance allowable for conventional smoke detectors. Intervals may vary according to calculations.
2. Follow manufacturer's written recommendations to determine the number and spacing of sampling points and the distance from sampling points to ceiling or roof structure and to forced ventilation system.
3. Each sampling point shall be identified by an applied decal.

P. Detector Bases:
1. Twist-lock detecting base designed to accommodate heat sensors or smoke detectors. Contact between the base and head shall be of the bifurcated type utilizing spring type, self-wiping contacts. Removal of the detector head shall interrupt the supervisory current of the fire alarm detection loop and cause a trouble signal at the control panel. The locking feature must be field removable when not required. UL listed suitable for location and intended use, dip switch selectable addressing, interchangeable sensor head, integral LED for power-on, trouble and alarm, locking anti-tamper device, 0 to 38 degrees C. and 10% to 90% relative humidity operation, mounting on 4 in square box.
2. Magnetically actuated test switch to provide for easy alarm testing at the sensor location.
3. Each sensor shall be scanned by the control panel for type identification to prevent inadvertent substitution of another sensor type. The control panel shall operate with the installed device but shall initiate a "Wrong Device" trouble condition until the proper type is installed or the programmed sensor type is changed.
4. The sensor's electronics shall be immune from false alarms caused by EMI and RFI.
5. Where required, provide relay driver output controlled either automatically or manually from the control panel.

Q. Manual Pull Stations:
1. Description: UL 38 listed; finished in red with molded, raised-letter operating instructions in contrasting color. Station shall show visible indication of operation. Mounted on recessed outlet box; if indicated as surface mounted, provide manufacturer's surface back box.
2. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.
   a. Single-action mechanism, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
   b. Indoor Protective Shield: Factory-fabricated, clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false-alarm operation.
   c. Weatherproof Protective Shield: Factory-fabricated, clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm.
   d. Pull handle shall be treated with ink, powder, or gel dye which can be used to help identify who pulled the alarm.
3. Station Reset: Key or wrench-operated switch.

2.4 INTELLIGENT INPUT/OUTPUT MODULES

A. Intelligent interface modules shall provide the means of interfacing direct shorting devices and providing independent controls to and from the control panel's analog circuit (SLC). The devices shall incorporate a custom microprocessor based integrated circuit that shall provide communication with its compatible control panel. Each devices microcomputer shall have the capacity of storing, in memory, identification information as well as important operating status information.

B. Output/Input: The interface module shall only be used for monitor and report of the contact device to be monitored. The interface module shall incorporate an addressable SPDT relay contact rated for 4 amps resistive and 3.5 amps inductive. The relay and contact device input shall be controlled as a separate function at the same address.

C. Dual Input: The intelligent interface module shall be a dual input module designed to supervise and monitor two sets of dry contacts. The dual interface module requires only one address setting but responds independently to each input. The dual input interface module shall be used to monitor the status of sprinkler water-flow and supervisory tamper valves.

D. Single Input: The intelligent interface shall be a single input module designed to be used to monitor and report of the contact device to be monitored. The module shall be installed in standard 4" square electrical box.

2.5 ADDRESSABLE INTERFACE MODULE

A. Where needed a conventional zone module shall connect to the signal line circuit, which will allow the use of conventional initiation devices.

2.6 NOTIFICATION DEVICES

A. Notification Appliances

1. Strobes/Speaker Strobes
   a. The strobes shall meet and be listed for UL Standard 1971 (Emergency Devices for the Hearing-Impaired) for Indoor Fire Protection Service
   b. Strobe shall be listed for indoor use, and shall meet the requirements of FCC Part 15 Class B.
   c. Strobe appliances shall produce a flash rate of one (1) flash per second over the Regulated Voltage Range, and shall incorporate a Xenon flashtube enclosed in a rugged Lexan® lens
   d. Chimes, Low-Level Output: Vibrating type, 75-dBA minimum rated output.
   e. Chimes, High-Level Output: Vibrating type, 81-dBA minimum rated output.
   f. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind the grille. Comply with UL 464. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet from the horn, using the coded signal prescribed in UL 464 test protocol.
   g. All inputs shall be compatible with standard, reverse polarity supervision of circuit wiring by the fire-alarm control unit.
   h. The Strobe shall be of low-current design.
   i. The selector switch for selecting the candela shall be tamper resistant
   j. The appliance shall be compatible with power supplies with built-in sync protocol when synchronization is required.
   k. The strobes shall not drift out of synchronization at any time during operation
   l. If the sync module or Power Supply fails to operate, (i.e. - contacts remain closed), the strobe shall revert to a non-synchronized flash rate.
   m. The strobes shall be designed for indoor surface or flush mounting.
   n. The Strobe Plate shall mount to either a standard, 4-inch square back box for flush mounting, or shall mount to the back box for surface mounting.
   o. All notification appliances shall be backward compatible.
2. Visible Notification Appliances: Xenon strobe lights complying with UL 1971 with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch-high letters on the lens.
   a. Rated light output:
      1) 15/30/75/110 cd, selectable in the field.
   b. Mounting: Wall mounted unless otherwise indicated.
   c. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
   d. Flashing shall be temporal pattern, synchronized with other units.
   e. Strobe leads: Factory connected to screw terminals.
   f. Mounting Faceplate: Factory finished, red.
3. Speakers/Speaker Strobes:
   a. Speakers shall be UL Standard 1480 for Fire Protective Service, and

speakers equipped with strobes shall be listed under UL Standard 1971 for Emergency Devices for the Hearing-Impaired.

b. Locate speakers for voice notification to provide intelligibility requirements
Speakers shall have the capability to be utilized for the announcement of non-fire messages.
c. High-Range Units: Rated 2 to 15 W.
d. Low-Range Units: Rated 1 to 2 W.
e. Mounting: Flush, semi recessed or surface mounted and bidirectional.
f. Matching Transformers: Tap range matched to acoustical environment of speaker location.
g. Speaker with strobes shall be certified to meet the requirements of FCC Part 15, Class B.
h. All speakers shall be designed for a field-selectable input of either 25 or 70 VRMS; with selectable power taps from 1/8 watt to 2 watts.
i. All wall-mount models shall have listed sound output of up to 89 dBA at 10 feet and a listed frequency response of 400 to 4000 Hz.
j. All ceiling-mount models shall have listed sound output of up to 87 dB at 10 feet and a listed frequency response of 400 to 4000 Hz.
k. Speaker shall incorporate a sealed-back construction.
l. All inputs shall employ terminals that accept #12 to #18 AWG wire sizes.
m. Strobe intensity, where Multi-Candela appliances are specified, shall have field-selectable settings, and shall be rated per UL Standard 1971 for:
    1) 15/30/75/110cd (wall mounting).
    2) 135/185cd (wall mounting).
    3) 15/30/75/110cd (ceiling mounting).
    4) 135/185cd (ceiling mounting)
n. Selector switch for selecting the candela shall be tamper resistant.
o. The strobe portion, when synchronization is required, shall be compatible with power supply with built-in protocol.
p. The strobes shall not drift out of synchronization at any time during operation
q. The strobes shall revert to a non-synchronized flash-rate, if the sync module or Power Supply should fail to operate (i.e. – contacts remain closed)
r. Wall-mount speaker and speaker-strobe appliances shall be designed for indoor- flush mounting to 4" x 2-1/8" electrical boxes without need for an extension ring or surface mounting
s. Ceiling-mount, speaker-strobe appliances shall be designed for indoor-flush mounting
t. Speaker and speaker strobe shall incorporate a speaker-mounting plate with a snap- on grille cover
u. The finish of the speakers and speaker strobes shall be white.
v. All speaker and speaker-strobe appliances shall be listed for Special Applications: Strobes are designed to flash at 1-flash-per-second minimum over their "Regulated Input Voltage Range"

B. Power Supply

1. The system shall operate on a 3-wire, 120-volt AC single phase service. Provide circuit breaker locking device on all power supply circuits.

C. Battery

1. The system shall be provided with enough maintenance free battery capacity to operate the entire system upon loss of normal 120 VAC power in a normal supervisory mode for a period of 24 hours with 15 minutes of alarm operation at the end of this period. The system shall automatically transfer to the standby batteries upon power failure. All battery charging and recharging operations shall be automatic.
2. A voltmeter and ammeter shall be provided to indicate battery voltage and charging current

D. Smoke-Alarm Verification

1. Initiate audible and visible indication of an "alarm verification" signal at the FACP.
2. Activate a listed and approved "alarm verification" sequence at the FACP and the detector.
3. Record events by the system printer.
4. Sound general alarm if the alarm is verified.
5. Cancel fire-alarm control unit indication and system reset if the alarm is not verified.

E. Power Supply for Supervision Equipment: Supply for audible and visual equipment for supervision of the ac power shall be from a dedicated dc power supply, and power for the dc component shall be from the ac supply.

F. Mechanical Air Handling Controls

1. The mechanical controls shall activate the air handling systems per life safety specification.
2. The control panel shall provide on/off/auto switch(es). In the automatic mode the mechanical controls shall operate the air handling systems as required. The control panel shall indicate "on" or "off" status of the air handling system via separate and distinct "on" and "off" LED indicators. Manual control shall be provided to override the automatic functions. A "positive feedback" input is to be provided to indicate true "on" or "off" status from contact closure of the air handling system. This positive feedback indication is to take precedence in determining true "on" or "off" status.
3. Upon reset of control panel air handling units shall sequentially start up to reduce electrical demand.

G. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, trouble, and supervisory signals to a remote alarm station through a digital alarm communicator transmitter and telephone lines – or – via an approved emergency radio communicator transmitter system.

H. Voice/Alarm Signaling Service: A central emergency communication system with redundant microphones, redundant preamplifiers, redundant amplifiers, and redundant tone generators provided as a special module that is part of the FACP.

1. Indicated number of alarm channels for automatic, simultaneous

transmission of different announcements to different zones, or for manual transmission of announcements by use of the central-control microphone. Amplifiers shall be UL 1711 listed.

a. Allow the application of and evacuation signal to indicated number of zones and, at the same time, allow voice paging to the other zones selectively or in any combination.
b. Programmable tone and message sequence selection.
c. Standard digitally recorded messages for "Evacuation" and "All Clear."
d. Generate tones to be sequenced with audio messages of the type recommended by NFPA 72 and that are compatible with tone patterns of the notification-appliance circuits of the fire-alarm control unit.

2. Notification-Appliance Circuits: NFPA 72, Class B.
3. Status Annunciator: Indicate the status of various voice/alarm speaker zones.
4. Preamplifiers, amplifiers, and tone generators shall automatically transfer to backup units, on primary equipment failure.

I. Service Modem: Ports shall be RS-232 for system printer and for connection to a dial-in terminal unit.
1. The dial-in port shall allow remote access to the fire-alarm control unit for programming changes and system diagnostic routines. Access by a remote terminal shall be by encrypted password algorithm.

J. Primary Power: 24-V dc obtained from 120-VAC service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signal, supervisory and digital alarm communicator transmitter shall be powered by the 24-V dc source.
1. The alarm current draw of the entire fire alarm system shall not exceed 80 percent of the power-supply module rating.
2. Power supply shall have a dedicated fused safety switch for this connection at the service entrance equipment. Paint the switch box red and identify it with "FIRE ALARM SYSTEM POWER."

K. Secondary Power: 24-V dc supply system with batteries and automatic battery charger and an automatic transfer switch.
1. Batteries: Sealed lead calcium.

L. Battery and Charger Capacity: Comply with NFPA 72. Surge Protection:
1. Install surge protection on normal ac power for the fire-alarm control unit and its accessories. Comply with Division 26 Section "SURGE PROTECTIVE DEVICES" for auxiliary panel suppressors.
2. Install surge protectors recommended by fire-alarm control unit manufacturer. Install on all system wiring external to the building housing the A fire-alarm control unit.

M. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

N. Power Supply and Batteries:

1. System shall be powered by from a listed and approved regulated supply of nominally 24Vdc.
2. Power supply shall be provided with appropriately sized/rated batteries to accommodate the system's power requirements for a duration of time required by the local AHJ in the event main AC power is interrupted.

2.7 Firefighters: Smoke Control System

A. Initiate Smoke Management services Operation:
1. Comply with sequence of operation described in Section 230993 "Sequence of Operations for HVAC DDC".
2. Fire alarm system shall provide all interfaces and control points required to properly activate smoke-management systems.
3. First Fire-alarm system initiating device to go into alarm condition shall active the smoke control functions.
4. Subsequent devices going into alarm condition shall have no effect on the smoke-control mode.

B. Addressable Relay Modules:

1. Provide address-setting means on the module. Store an internal identifying code for control panel use to identify module type.
2. Allow the Control panel to switch the relay contacts on command.
3. Have a minimum of two normally open and two normally closed contacts available for field wiring.
4. Listed for controlling HVAC fan motor controllers.

2.8 Magnetic Door Holders

A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.

1. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.
   a. Electromagnets: require no more than 3 W to develop 25-lbf holding force.
   b. Wall-mounted units: Flush mounted unless otherwise indicated.
   c. Rating: 120-V ac.
2. Material and Finish: Match door hardware.

2.9 DACT (Digital Alarm Communications Transmitter)

A. Digital Alarm Communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632.

B. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture one telephone line(s) and dial a preset number for a re mote central station. When contact is made with central station (s), signals shall be transmitted. If service on either line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transit the signal indicating loss of telephone to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.

C. Local functions and display at the digital alarm communicator transmitter shall include the following:
1. Verification that both telephone lines are available.
2. LED display.
3. Manual test report function and manual transmission clear indication.
4. Communications failure with the central station or fire-alarm control unit.

D. Digital data transmission shall include the following:
1. Address of the alarm- initiating device.
2. Address of the supervisory signal.
3. Address of the trouble-initiating device.
4. Loss of ac supply.
5. Loss of power.
6. Low battery.
7. Abnormal test signal.
8. Communication bus failure.

E. Secondary power: Integral rechargeable battery and automatic charger.

F. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

G. The system shall provide off premises communications capability using a Digital Alarm Communications Transmitter (DACT) for sending system events to multiple Central Monitoring Station (CMS) receivers over conventional telephone lines.
1. The system shall provide the CMS(s) with point identification of system events using 4/2, Contact ID (SIA DC-05) or SIA DCS protocols. The system shall also transmit an alphanumeric system activity message, by event, to a commercial paging system provided by the owner, using TAP Pager protocol and an internal V.32BIS or greater 14.4Kbaud modem.
2. The dialer shall support up to 255 individual accounts and to send account information to eight (8) different receivers, each having a primary and secondary telephone access number. System events shall be capable of being directed to one or more receivers depending on event type or location as specified by the system design.
3. In the event of a fire alarm panel CPU failure during a fire alarm condition, the DACT degrade mode shall transmit a general fire alarm signal to the CMS.
4. The owner shall arrange for two (2) dedicated loop-start phone lines to be terminated using two RJ31X jacks within 5 ft of the main fire-alarm control unit.

2.10 GRAPHIC ANNUNCIATOR

A. Graphic Annunciator Panel: Mounted in Aluminum frame with non-glare, minimum 3/16-inch thick, clear acrylic over graphic representation of the facility. Detector locations shall be represented by red LED Lamps. Normal system operation shall be indicated by a lighted, green LED. Trouble and Supervisory alarms shall be represented by an amber LED.
1. Comply with UL 864.
2. Operating voltage shall be 24-V dc provided by a local 24-V power supply provided with the annunciator.

3. Include built-in voltage regulation, reverse polarity protection, RS 232/422 serial communications, and a lamp test switch.
4. Semi-flush mounted in a NEMA 250, Type 1 Cabinet, with key lock and no exposed screws or hinges.
5. Graphic representation of the facility shall be a CAD drawing and each detector shall be represented by an LED in its actual location. CAD drawing shall be 1/8 inch per foot scale or larger.
6. The LED representing a detector shall flash two times per second while detector is in alarm.

B. Graphic Annunciator Workstation: PC-Based, with fire-alarm annunciator software with historical logging, report generation, and a graphic interface showing all alarm points in the system. PC with operating system software, hard drive, digital display monitor, with wireless keyboard and mouse.

2.11 REMOTE ANNUNCIATOR

A. Duplicate annunciator functions shall match those of the fire-alarm control unit for alarm, supervisory, and trouble indications. Also, duplicate manual switching functions of the fire-alarm control unit, including acknowledging, silencing, resetting, and testing

B. Tone Alert: Duplicates the control panel tone alert during alarm & trouble conditions.

C. Display Type and Functional Performance: Alphanumeric display shall match the fire-alarm control unit. Controls with associated LED indicators permit acknowledging, silencing, resetting, and testing functions for alarm, supervisory, and trouble signals identical to those in the fire-alarm control unit.

D. Mounting: Flush cabinet, NEMA 250, Type 1.

2.12 ADDRESSABLE INTERFACE DEVICE

A. General:
1. Include address-setting means on the module.
2. Store an internal identifying code for control panel use to identify the module type.
3. Listed for controlling HVAC fan motor controllers.

B. Monitor Module: Microelectronic module providing a system address for alarm-initiating devices for wired applications with normally open contacts.

C. Integral Relay: Capable of providing a direct signal to elevator controller to initiate elevator recall.
1. Allow the control panel to switch the relay contacts on command.
2. Have a minimum of two normally open and two normally closed contacts available for field wiring.

D. Control Module:
1. Operate Notification Appliances.
2. Operate solenoids for use in sprinkler service.

2.13 RADIO ALARM TRANSMITTER

A. Transmitter shall comply with NFPA 12221 and 47 CFR 90.

B. Description: Manufacturer's standard commercial product: factory assembled, wired and tested ready for installation and operation.
1. Packaging: A single, modular, NEMA 250, Type 1 metal enclosure with a tamper-resistant flush tumbler lock.
2. Signal Transmission Mode and Frequency: VHF or UHF 2-W power output, coordinated with operating characteristics of the established remote alarm receiving station designed by the owner.
3. Normal power input: 120-V ac.
4. Secondary power: Integral-sealed, rechargeable, 12-V battery and charger. Comply with NFPA 72 requirements for battery capacity: submitted calculations.
5. Antenna: Omnidirectional, coaxial half-wave, dipole type with driving point impedance.
6. Antenna Cable: Coaxial Cable with impedance matched to the transmitter output impedance.
7. Antenna -Cable Connectors: Weatherproof.
8. Alarm Interface Devices: Circuit boards, modules, and other auxiliary devices, integral to the transmitter, matching fire-alarm, and other system outputs to message-generating inputs of the transmitter that produce required message transmissions.

C. Functional Performance: Unit shall receive alarm, supervisory, or trouble signal from fire-alarm control unit or from its own internal sensors or controls and shall automatically transmit signal along with a unique code that identifies the transmitting station to the remote central station. Transmitted messages shall correspond to standard designations for fire-reporting system to which signal is being transmitted and shall include separately designated messages in response to the following events and conditions:
1. Transmitter Low-battery Condition: Sent when battery voltage is below 85 percent of rated value.
2. System test message: Initiated manually by a test switch withing the transmitter cabinet, or automatically at an optionally preselected time, once every 24 hours, with transmission time controlled by a programmed timing device integral to transmitter controls.
3. Transmitter Trouble message: Actuated by failure, in excess of one-minute duration of the transmitter normal power source, derangement of the wiring of the transmitter, or any alarm input interface circuit or device connected to it.
4. Local Fire-Alarm System Trouble Message: Initiated by events or conditions that cause a trouble signal to be indicated on the building system.
5. Local Fire-Alarm System Alarm Message: Actuated when the building system goes into an alarm state. Identifies device that initiated the alarm.
6. Local Fire-Alarm System, Supervisory-Alarm Message: Actuated when the building alarm system indicates a supervisory alarm.

2.14 SYSTEM PRINTER

A. Printer shall be listed and labeled as an integral part of fire-alarm system.

2.15 NETWORK COMMUNICATIONS

A. Provide network communications for fire-alarm system according to fire-alarm manufacturer's written requirements.

B. Provide network communications pathway per manufacturer's written requirements and requirements in NFPA 72 and NFPA 70.

C. Provide integration gateway using BACnet or Modbus for connection to building automation system.

2.16 DEVICE GUARDS FOR PHYSICAL PROTECTION

A. Description: Welded wire mesh of size and shape for the manual station, smoke detector, gong, or other device requiring protection.

1. Factory fabricated and furnished by manufacturer of the device.
2. Finish: Paint of color to match the protected device.

2.17 WIRE AND CABLE

A. Wire and cable for fire alarm systems shall be UL listed and labeled as complying with NFPA 70, Article 760.

B. Signaling Line Circuits: Twisted, shielded pair, not less than No. 18 AWG.

C. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.
1. Line-Voltage Circuits: No. 12 AWG, minimum.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Fee, Permits and Inspections
1. Permit. Obtain separate fire alarm permit. Submit permit shop drawings to the AHJ as defined in NFPA 72. The AHJ for this project is – City of San Antonio and Building Official(s). One copy of the above shop drawings with this approval evidenced shall be included with the submittal.
2. Schedule periodic inspections by the AHJ during the installation and shall make any minor corrections, deletions, relocations, or additions to the system as required for acceptance of the completed system by the AHJ.
3. Include fees for fire alarm permit and AHJ inspections in the base bid.

B. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.
1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed before installation begins.
2. Examine roughing in for electrical connections to verify actual locations of connections before installation.
3. Proceed with installation only after unsatisfactory conditions have been

corrected.

C. Comply with NPFA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install all electrical wiring to comply with requirements in NPFA 70 including, but not limited to, Article 760, "Fire Alarm Systems"

1. Devices placed in service before all other trades have completed cleanup shall be replaced.
2. Devices installed but not yet placed in service shall be protected from construction dust, debris, dirt, moisture, and damage according to manufacturer's written storage instructions.

D. Connecting to Existing Equipment: Verify that existing fire-alarm system is operational before making changes or connections.

1. Connect new equipment to existing control panel in existing part of the building.
2. Connect new equipment to existing monitoring equipment at supervising station.
3. Expand, modify, and supplement existing control equipment as necessary to extend existing control functions to the new points. New components shall be capable of metering with existing configuration without degrading the performance of either system.

E. Approved Equipment and Permit

1. No equipment shall be delivered to the jobsite until shop drawings have been reviewed and approved by AHJ. A reviewed and AHJ approved shop drawing set shall be continuously available at the jobsite during construction.
2. Obtain a permit from the local AHJ prior to installation of equipment.

3.2 INSTALLATION

A. Smoke or Heat Detector Spacing: Spacing of heat detectors shall be determined based on guidelines and recommendations in NFPA 72.
1. Smooth ceiling spacing shall not exceed 30 ft.
2. Spacing detectors in irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Annex A or Annex B in NFPA 72.
3. HVAC: Locate detectors not closer than 3 feet from air-supply diffuser or return-air opening.
4. Lighting Fixtures: Locate detectors not closer than 12 inches from any part of a lighting fixture.

B. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Comply with IMC, NFPA 72, and NFPA 90A if necessary. Install sampling tubes so they extend the full width of the duct
1. Do not install smoke detector in duct smoke-detector housing during construction. Install detector only during system testing and prior to system turnover.

C. Install a cover on each smoke detector that is not placed in service during

construction. Cover shall remain and not directly above pendant mounted or indirect lighting.

D. Heat Detectors in Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location. Do not install smoke detectors in sprinkler elevator shafts.

E. Visual Annunciators and Combination Audible/Visual Annunciators: 80" above floor or 6" below ceiling whichever is lower. Install on ceiling only as supplemental in the rack server area.

F. Install wall mounted equipment, with tops of cabinets not more than 78 inches above the finished floor.
1. Comply with requirements for seismic-resistant devices specified in Section 26 05 48. "Seismic Controls for Electrical Systems".

G. Manual Fire-Alarm Boxes:
1. Install manual fire-alarm box in the normal path of egress within 60 inches of the exit doorway.
2. Mount manual fire-alarm box on a background of a contrasting color.
3. The operable part of manual fire-alarm box shall be between 42 inches and 48 inches above floor level. All devices shall be mounted at the same height unless otherwise indicated.

H. Remote Status and Alarm Indicators: Install in a visible location near each smoke detector, sprinkler water-flow switch, and valve-tamper switch that is not readily visible form normal viewing position.

I. Device location-Indicating Lights: Locate in public space near the device they monitor.

J. Antenna for Radio Alarm Transmitter: Mount to building structure where indicated. Use mounting arrangement and substrate connection that resists 100-mph wind load with a gust factor of 1.3 without damage.

K. Annunciator: Install with top of panel not more than 70 inches above the finished floor.

L. Wiring Installation
1. Install wiring according to the following:
   a. NECA 1.
   b. TIA/EIA 568-A.
2. Wiring Method: Install wiring in metal raceway according to Division 26 Section "Raceways" or cable tray according to division 26 "Cable Tray"
   a. Fire alarm circuits and equipment control wiring associated with the fire alarm system shall be installed in cable tray or J-hook system.
   b. Pathways above recessed ceilings and in non-accessible locations may be routed exposed.
      1) Exposed pathways located less than 96 inches above the floor shall be installed in EMT.
   c. Pathways shall be installed in EMT Conduit.
   d. Exposed EMT shall be painted red enamel.

3. Provide 3/4", 3 #12 from control panel to 20 ampere circuit breaker(s) with lock-on device in a 120-volt panel board for system power.
4. Provide 3/4" raceway and two 4 pair unshielded twisted pair, UL listed category 5e cables from the control panel to the telephone terminal board as required for automatic central station monitoring and notification.
5. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.
6. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.
7. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and a different color-code for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.
8. Install Class B supervised initiation, notification, and sprinkler system circuits in quantities necessary to accommodate all current devices and 30% expansion. Do not load any circuits to more than 70% of listed capacity.

M. AUXILIARY CONTROLS

1. Conductors and power supplies shall be of enough size and be installed to minimize voltage drop consistent with the proper operation of all devices. Auxiliary control circuits shall be separate from initiation and evacuation signal circuits. Fan shutdown control circuits need not be electrically supervised and may be incorporated into the fire alarm raceway system, except that limited energy circuits shall be routed separately from line voltage circuits as required by Code (NEC Article 725).

3.2 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals according to Division 26 Section "Electrical Identification."

B. Install instructions frame in a location visible from the fire-alarm control unit.

C. Paint power-supply disconnect switch red and label "FIRE ALARM."

3.3 CONNECTIONS

A. Ground the fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to the fire-alarm control unit.

B. For Fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Section 087100 "Door Hardware". Connect hardware and devices to fire-alarm system.
   1. Verify that hardware and devices are listed for us with installed fire-alarm system before making connections.

C. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 36 inches from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.
   1. Alarm-initiating connection smoke-control system (smoke management) at firefighters' smoke-control system panel.
   2. Alarm-initiating connection to stairwell and elevator-shaft pressurization systems.
   3. Smoke dampers in air ducts of designated HVAC duct systems.
   4. Magnetically held-open doors.
   5. Electronically locked doors and access gates.
   6. Alarm-initiation connection to elevator recall system and components.
   7. Alarm-initiation connection to activate emergency lighting control.
   8. Alarm-initiation connection to activate emergency shutoffs for gas and fuel supplies.
   9. Supervisory connections at valve supervisory switches.
   10. Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.
   11. Supervisory connections at fire-pump power failure including a dead-phase or phase-reversal condition.
   12. Supervisory connections at fire-pump engine control panel.

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems".

B. Install framed instructions in a location visible from fire-alarm control unit.

3.5 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.

B. Perform the following field tests and inspections and prepare test reports:
   1. All Alarm Initiating Devices shall be observed and logged for correct level and sensitivity. These devices and their bases shall be tagged with adhesive tags located in an area not visible when installed, showing the initials of the installing technician and date. Detectors that are outside of their marked sensitivity range shall be replaced.
   2. Wiring runs shall be tested for continuity, short circuits and grounds before system is energized. Resistance, current and voltage readings shall be made as work progresses.
   3. The acceptance inspector shall be notified before the start of the required tests. All items found at variance with the drawings or this

specification during testing or inspection by the acceptance inspector shall be corrected.

4. Test reports shall be delivered to the acceptance inspector as completed.
5. Perform each electrical test and visual and mechanical inspection listed in NFPA 72. Certify compliance with test parameters. All tests shall be conducted under the direct supervision of a NICET technician certified under the Fire Alarm Systems program at Level III.
6. Visual Inspection: Conduct a visual inspection before any testing. Use completed record drawings and system documentation for the inspection. Identify improperly located, damaged, or nonfunctional equipment, and correct before beginning tests.
   a. Complete visual inspection as required by the "Completion Documents, Preparation" table in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
   b. Comply the "Visual Inspection Frequencies" table in the "Inspection" Section of the "Inspection, teasing and Maintenance" chapter in NFPA 72; retain the "initial/Reacceptance" column and list only the installed components.
7. Testing: Follow procedure and record results complying with requirements in NFPA 72.
8. Test and Inspection Records: Prepare according to NFPA 72, including demonstration of sequences of operation by using the matrix-style form in Appendix A in NFPA 70.

C. Tests

1. Introduce Smoke into the Detector Assembly to provide a basic functional test.
2. Perform test and inspections reports.
3. Field tests shall be witnessed by authorities having jurisdiction.
4. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
5. Perform the following tests and inspections with the assistance of factory-authorized representative:
   a. Visual Inspection: conduct visual inspection prior to testing.
      i. Inspection shall be based on completed record Drawings and system
      Documentation that is required by the "Completion Documents,
      Preparation" table in the "Documentation" section of the "Fundamentals" chapter in NPFA 72.
      ii. Comply with the "Visual Inspection Frequencies" table in the "Inspection" section of the Inspection, Testing, and Maintenance" chapter in NPFA 72.
   b. Test audible appliances for the private operating mode according to
   manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
   c. Test visible appliances for the public operating mode according to manufacturer's written instructions.

d. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" section of the "Fundamentals" chapter in NFPA 72 and the "Inspection", Testing and Maintenance" chapter in NFPA 72.

6. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.
7. Fire-alarm system shall be considered defective if it does not pass tests and inspections.

3.6 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning of Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include preventive maintenance, repair, or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Part and supplies shall be manufacturer's authorized replacement parts and supplies.
   1. Include visual inspections according to "Visual Inspection Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
   2. Perform tests er the "Test Methods" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NPFA 72.
   3. Perform tests per the "Testing Frequencies" table in the "Testing" paragraph of "Inspection, Testing and Maintenance" chapter in NFPA 72.

3.7 SOFTWARE SERVICE AGREEMENT

A. Comply with UL 864.

B. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

C. Upgrade Service: At Substantial completion, update software to latest version. Install

and program software upgrades that become available within two years form date of Substantial Completion.
   1. Upgrade notice: At least 30 days to allow Owner to schedule access to system and to upgrade computer equipment if necessary.

3.8 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project outside normal occupancy hours for this purpose.

B. Follow-Up Tests and Inspections: After date of Substantial Completion, test the fire alarm system complying with testing and visual inspection requirements in NFPA 72. Perform tests and inspections listed for three monthly, and one quarterly, periods.

C. Semiannual Test and Inspection: Six months after date of Substantial

Completion, test the fire alarm system complying with the testing and visual inspection requirements in NFPA 72. Perform tests and inspections listed for monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.

D. Annual Test and Inspection: One year after date of Substantial Completion, test the fire alarm system complying with the testing and visual inspection requirements in NFPA 72. Perform tests and inspections listed for monthly, quarterly, semiannual, and annual periods. Use forms developed for initial tests and inspections.

3.9 TRAINING

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the fire alarm system, appliances, and devices. Refer to Division 01 Section "Demonstration and Training."

B. Documentation:
   1. System documentation shall be furnished to the owner and shall include but not be limited to the following:
      a. System record drawings and wiring details including one set of reproducible drawings, and a CD ROM with copies of the record drawings in DXF format for use in a CAD drafting program.
      b. System operation, installation, and maintenance manuals.
      c. System matrix showing interaction of all input signals with output commands.
      d. Documentation of system voltage, current and resistance readings taken during the installation and testing phases of the system installation.
      e. System program showing system functions, controls and labeling of equipmentand devices.

END OF SECTION 283111

SECTION 329300 - LANDSCAPE PLANTING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Work specified in this section: Provide all labor, materials, transportation, and services necessary to furnish and install all landscape planting, complete in place, as shown and specified on drawings.

B. Landscape work shall include, but is not limited to, fine grading, soil preparation, planting, seeding, sodding, pruning, fertilizing and pest/disease control.

1.2 RELATED WORK

A. The requirements of the "General and Supplementary Conditions of the Contract" and Division 1 specification sections shall apply to all work of this Section with the same force and effect as though repeated in full herein.

B. General Scope of Work and Requirements: Section 01000.

C. Sodding and Seeding See Specifications.

D. Site Grading: See Specifications.

E. Irrigation System: Section 328100.

1.3 REFERENCES

A. ANSI Z60.1, American Standard for Nursery Stock Edition, 2004.

B. ANSI A300 - American National Standard for Tree Care Operations -- Tree, Shrub and Other Woody Plant Maintenance -- Standard Practices; 2001.

C. Hortus third, 1976 - Cornell University - Plant Nomenclature.

D. Grades and Standards for Nursery Stock," Texas Association of Nurserymen.

E. Turfgrass Producers International (TPI) - Guideline Specifications to Turfgrass Sodding.

F. U.S. Department of Agriculture Rules and Regulations under the Federal Seed Act and the Texas Seed Law.

1.4 SUBMITTALS

A. General Requirements:

1. The Contractor shall furnish the articles, equipment, materials, or processes specified by name in the drawings and specifications. No substitution will be allowed without prior approval by the Landscape Architect.
2. Complete material list shall be submitted prior to performing any work. Material list shall include the manufacturer, description of all materials to be used and samples as outlined below.
3. Submit contractor qualifications per 1.5 Quality Assurance and Requirements.

B. Plant Selection:

1. Submit plant schedule on contractor letterhead naming quantities and supplier of each tree for Landscape Architect's approval.
2. Submit certification of sod species and location of sod source.
3. Submit certification of seed and mulching agent.
4. If material is to be approved on-site, tag and maintain plant material as representative samples. Samples may be use to complete installation, provided they remain tagged until final acceptance of entire installation.

C. Miscellaneous Materials:

1. Submit for approval 1 gallon quantities and product information of topsoil, prepared soil, mulch and granite gravel.

2. Submit topsoil analysis with recommendations of amendments required to support plant growth. See paragraph 2.4 Source Quality Control and Tests, D.
3. Submit for approval product information on packaged materials, edger, tree stakes, tree boots, fabric and fertilizer, herbicide and insecticide. Samples shall be approved by the Landscape Architect before use on the project.
4. All samples shall be delivered in a box. Clearly mark samples with job name and contractor name.

D. Record Drawings:
1. The Contractor shall provide and keep up-to-date an "as-built" set of blue line ozalid prints which shall be corrected daily and show every change from the original drawings and specifications and the exact "as-built" locations, sizes of plant material installed. This set of drawings shall be kept on the site and shall be used only as a working set.
2. Before the date of the final inspection, the Contractor shall transfer all information from the "as-built" prints to a mylar or similar material. All work shall be in pen to allow proper printing of original.
3. On or before the date of the final inspection, the Contractor shall deliver the completed drawings to the Owner. Delivery of the record drawings will not relieve the Contractor of the responsibility of furnishing required information that may be omitted from the prints.

E. Maintenance Schedule: Submit maintenance schedule identifying procedures to be accomplished during the year. The schedule shall be typewritten and specify procedures to be accomplished month by month.

F. Submit 3 copies of written guarantee, in the terms specified under "Guarantee" provisions of these specifications, and signed by the Contractor.

1.5 QUALITY ASSURANCE AND REQUIREMENTS

A. Permits and Fees: The Contractors shall obtain and pay for any and all permits and all inspections as required. Contractor shall also be responsible for all fees and costs involved for work.
1. Landscape Contractor shall comply with AHJ Inspector directions with agreement from Landscape Architect without additional cost to Owner.

B. Ordinances and Regulations: All local, municipal and state laws, and rules and regulations governing or relating to any portion of this work are hereby incorporated into and made a part of these specifications, and their provisions shall be carried out by the contractor. Anything contained in these specifications shall not be construed to conflict with any of the above rules and regulations or requirements of the same. However, when these specifications and drawings call for or describe materials, workmanship, or construction of a better quality, higher standard, or larger size than is required by the above rules and regulations, the provisions of these specifications and drawings shall take precedence.

C. Personnel: Personnel shall be supervised by a Certified Landscape Professional Contractor (CLPC) as administered by Texas Association of Landscape Contractors (TALC) or hold a college degree relating to the landscape industry or an approved equivalent. Employ only experienced personnel who are familiar with the required work. Provide adequate supervision by a qualified foreman with minimum of five years experience.

D. Plant Material: Plants shall be subject to inspection and approval of Landscape Architect at place of growth or upon delivery for conformity to specifications. Such approval shall not impair the right of inspection and rejection during progress of the work. Inspection and tagging of plant material by the Landscape

Architect is for design intent only and does not constitute the Landscape Architects' approval of the plant materials in regards to their health and vigor as specified in Part 2, Section 2.1 Plant Material. The health and vigor of the plant material is the sole responsibility of the Contractor.

1. General: Comply with applicable federal, state, county, and local regulations governing, landscape materials and work.
2. Any plant material in shock, decline or not meeting specified planting size, height and caliper shall be rejected by the Landscape Architect at any time during the project.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver plant material to site in containers. Protect plant material from sun-scald and wind burn during transport to site. Prune only limbs that have broken in transport. Keep plants watered as required.

B. Deliver grass seed mixture in sealed containers. Seed in damaged packaging is not acceptable. Deliver seed mixture in containers showing percentage of seed mix, year of production, net weight, date of packaging, and location of packaging.

C. Deliver packaged materials in containers showing weight, analysis and name of manufacturer. Protect materials from deterioration during delivery and while stored at site.

1.7 SUBSTITUTIONS

A. Submit proof to Landscape Architect if plant material is not available 30 days prior to plant installation. Substitution will be approved by Owner or Landscape Architect by Architect's Supplemental Instructions.

1.8 GUARANTEE

A. Guarantee plants and trees for one year after final acceptance. Replace dead materials and materials not in vigorous, thriving condition as soon as weather permits and on notification by Owner. Replace plants, including trees, which have partially died thereby damaging shape, size or symmetry.

B. Replace plants and trees with same kind and sizes as originally planted, at no cost to Owner. Provide one year guarantee on replacement plants. At direction of the Landscape Architect, trees may be replaced at the start of next year's planting or digging season. In such cases, remove dead trees immediately. Protect irrigation system and any other piping, conduit, or other work during replacement. Repair any damage immediately.

C. Guarantee excludes replacement of plants because of injury by storm, drought, hail, freeze, insects or diseases, and other acts of God contacted after final acceptance.

1.9 PROJECT CONDITIONS

A. Site Utilities:

1. Determine locations of underground utilities, especially site lighting, cable, telephone, and irrigation lines. Perform all work in a manner which will avoid possible damage. Do not permit heavy equipment or trucks to damage utilities. Hand excavate, as required to minimize possibility of damage to underground utilities.
2. Coordinate work with the irrigation contractor to prevent damage to underground wire and other obstruction work located in landscape areas.
3. Any damage to utilities shall be repaired by contractor.

B. Condition of Surfaces: All shrub and groundcover planting areas will be left at

finished grade.

C. Water will be provided on site by the Owner. Landscape contractor will provide hoses, other watering equipment and labor necessary for the work.

1.10 SCHEDULES

The Contractor shall begin exterior landscape work upon acceptance of the Contract by the Owner. Landscape Contractor shall submit a schedule for the work to be performed to the Landscape Architect for approval.

1.11 PROTECTIONS

All items required to complete this contract remain the property and responsibility of the Contractor until final acceptance. Take adequate precautions to protect all work and materials against damage. Cooperate fully with other trades to insure a satisfactory completion.

1.12 MAINTENANCE SERVICE

A. Maintain plant material until Date of Substantial Completion.

B. Maintain plant materials immediately after placement and until plants are well established and exhibit a vigorous growing condition.

C. Maintenance to include:

1. Cultivation and weeding plant beds and tree pits.
2. Applying herbicides for weed control of all areas and plant materials in accordance with manufacturer's instructions. Remedy damage resulting from use of herbicides.
3. Applying insecticides for insect control and fungicides for fungus control of all areas and plant materials in accordance with manufacturer's instructions. Remedy damage from use of chemicals. Remedy damage resulting from use of chemicals.
4. Irrigating sufficiently to saturate root system of all plant material and sustain live and promote growth.
5. Pruning, including removal of dead or broken branches, and treatment of pruned areas or other wounds.
6. Disease control. Provide chemicals as required to control any disease that may occur during the maintenance period. Notify Owner and Landscape Architect for any problems.
7. Maintaining guys and tree stakes. Adjust to keep guy wires firm. Repair or replace accessories when required.
8. Replacement of mulch.
9. Watering, mowing, edging, weeding and fertilizing of lawn areas.

PART 2 - PRODUCTS

2.1 PLANT MATERIALS

A. General:

1. Plants shall be in accordance with the latest edition of "American Standard for Nursery Stock" sponsored by the American Association of Nurserymen, Inc. (A.A.N.). All plants shall have a normal habit of growth and shall be sound, healthy, vigorous and free of insect infestations, plant diseases, sunscalds, fresh abrasions of the bark, excessive abrasions, in shock or other objectionable disfigurements. If the sample plants inspected are found to be defective, the Landscape Architect reserves the right to reject the entire lot or lots of plants represented by the defective samples. Any plants rendered unsuitable for planting because

of this inspection will be rejected and will be the responsibility of the Contractor and removed from site.

2. The size of the plants will correspond with that normally expected for species and variety of commercially available nursery stock or as specified on drawings. The minimum acceptable size of all plants measured before pruning with the branches in normal position, shall conform with the measurements, specified on the drawings in the plant list. Plants larger in size than specified may be used with no change in contract price. If the use of larger plants is approved, the rootball for each plant will be increased proportionately.
3. Under no conditions will there be any substitutions of plants or sizes listed on the accompanying plans, except with the express consent of the Landscape Architect.
4. Plant material shall be true to botanical and common name and variety as specified in "American Standard for Nursery Stock Editions" and "Standardized Plant Names."
5. Plant materials shall be in conformance for rootball depth and width per ANSI Z60.1, American Standard for Nursery Stock Edition, 2004.
6. Plants shall be hardy under climatic conditions similar to those in locality of project.

B. Shade and Ornamental Trees:
1. Healthy, vigorous, full-branched, well-shaped, trunk diameter and height requirements as specified. Trees shall be in containers unless otherwise noted on plans.
2. B&B trees shall not be accepted for containerized materials.
3. Specified B&B trees shall have rootballs that are firm, neat, slightly tapered, heeled for a period of one (1) year.
4. Trees with loose or broken rootballs at time of planting shall be rejected.
5. Trees in grow bags, grow liners will be rejected.
6. Trees will be individually approved by the Landscape Architect.
7. Rootballs shall be 10" in diameter for each 1" caliper measured 6" above the tree rootball.
8. All Trees must have a central leader that has not been cut.

C. Shrubs and Perennials: Nursery grown, healthy, vigorous, bushy, well branched, of normal habit of growth for species, free from disease, insect eggs and larvae. Specified sizes shall be before pruning, and plants shall be measured with their branches in normal position.

D. Turf Materials:
1. Sod: TPI, Certified Turfgrass Sod quality; cultivated grass sod; with strong fibrous root system, rich green in color, free of stones, burned or bare spots, free of foreign grasses, weeds and nut grass; Minimum age of 18 months, with root development that will support its own weight without tearing, when suspended vertically by holding the upper two corners.
a. JaMur Zoysia (*Zoysia* 'JaMur')
b. Deliver to site on pallets. Do not stack for more than 24 hours between time of cutting and time of delivery.

2.2 SOIL PREPARATION MATERIALS

A. Topsoil: Existing topsoil shall be stockpiled for reuse on site.

B. Soil Amendment: 4-Way Mix, available from New Earth Compost & Soils, 210-661-5180.

C. Manure: Composted manure, available from New Earth Compost & Soils, 210-661-5180.

D. Peat Moss: Commercial sphagnum moss or hyphum peat, or decomposed pine bark consisting of natural occurrence, brown in color, clean, low in content or mineral and woody material, mildly acidic, either granulated or shredded.
E. Sand: Clean, washed, sharp sand, fine to coarse sizes.
F. Fertilizer:
   1. Turf Fertilizer: Complete fertilizer with an organic base, uniform in composition, dry and free flowing. Deliver fertilizer to site in original unopened containers, each bearing manufacturer's guaranteed statement of analysis. Fertilizer shall contain 12% nitrogen, 12% phosphoric acid, 12% potash, unless otherwise approved.
   2. Tree and Shrub Fertilizer: Agriform 20-10-5 planting tablets 21 gram.
G. Herbicide:
   1. Pre-emergent herbicide shall be Eptam Granules by Gowan Company, or approved equal.
   2. Post-emergent herbicide shall be Round-Up by Monsanto Corp., or approved equal.
H. Pesticides:
   1. Fungicides: Mancozeb, Armada
   2. Insecticides: Dursaban, Sevin, Volck Oil
   3. Other chemicals: Submit information as required.

2.3 MISCELLANEOUS MATERIALS
A. Mulch: Mulch shall be Double Shredded Native Mulch, available from New Earth Compost & Soils, 210-661-5180, Or from Solid Waste Management Department 4410 W. Piedras Dr. San Antonio TX 78228 210-207-6428 David Newman.
B. Gravel: Gravel shall be 1" diameter scale Texas Blend gravel and shall be clean, washed, hard, sound, durable, uniform in quality, and free of any detrimental matter. Available from Keller Material, Inc., San Antonio, Texas, (210) 648-4221.
C. Water: Water will be available on site.
D. Steel edger: Pro-steel or Ryerson edger, 1/8" x 4" and stakes.
E. Filter Fabric: Dewitt's Pro-5 Weed Barrier, 5 oz. woven, needle punched, polypropylene fabric.
F. Stakes: Metal T-posts, 6' ht., green in color.
G. Wire: Minimum 10 gauge wire, provide 2 strands of pliable galvanized iron wire.
H. Hose: 3/4" diameter, 2 ply, green rubber hose. Cut in sufficient length to protect tree from wire damage. Thread wire through hose.
I. Tree Boot: Deep Root ArborGard+, Model AG9-4 or approved equal. Tree trunk protector to prevent damage from trimmers and mowers. 9" ht. with a 4" diameter. Made of polyethylene 0.060" (1.52 mm) thickness.
J. Gatorbag: TreeGator Bag, 20 gallon, UV Treated Polyethylene reinforced nylon bag.

2.4 SOURCE QUALITY CONTROL AND TESTS
A. Section 01400 - Quality Requirements: If existing, excavated, on-site soil is to be reused, provide a chemical analysis of existing topsoil.
B. Soil analysis will ascertain the percentage of nitrogen, phosphorus, potash, soluble salt, organic matter and pH value.
C. Submit minimum 1 gallon sample of topsoil proposed. Forward another sample to approved testing laboratory in sealed containers to prevent contamination.
D. Testing is not required for imported soil if recent tests are available. Submit these test results to the Landscape Architect for approval. Contractor is to indicate, by test results, information (amendments both organic and inorganic) necessary to amend soil to support plant growth.

E. Soils analysis must be dated within 45 days of installation of topsoil.

PART 3 - EXECUTION

3.1 INSPECTION

A. Observe site prior to construction and accept site when satisfied with conditions. Landscape Contractor shall be responsible for shaping all planting areas as indicated on plans or as directed by Landscape Architect.

B. Inspect trees, shrubs and liner stock plant material for injury, insect infestation and trees and shrubs for improper pruning.

C. Do not begin planting until deficiencies are corrected or plants replaced. Do not start work until grading is complete and approved by Engineer or Architect.

3.2 SOIL PREPARATION

A. Preparation of Subgrade:

1. Prepare subgrade to eliminate uneven areas. Maintain profiles and contours. Make changes in grade gradual. Blend slopes into level areas.
2. Remove foreign materials, rocks, base materials, weeds and undesirable plants and their roots. Remove contaminated subgrade.
3. Scarify subgrade to a depth of 4 inches of soil after compaction minimum. Repeat cultivation in areas where equipment, used for hauling and spreading topsoil, has compacted subsoil.

B. Placing Topsoil:

1. Spread stockpiled topsoil to a minimum depth of 4 inches over entire area to be planted. Rake smooth.
2. Place topsoil during dry weather and on dry unfrozen subgrade. Remove organic matter and foreign non-organic material from topsoil while spreading. Break up soil clods as possible, remove those that cannot be broken.
3. Grade topsoil to eliminate rough, low or soft areas, and to ensure positive drainage.
4. Install topsoil into pits and beds intended for plant root balls, to a minimum thickness of 6 inches.

C. Soil Preparation for Bed Areas:

1. Final grades by the General Contractor are expected to be at finished grade. After approximate finished grades have been established, soil shall be conditioned and fertilized in the following manner. Existing soil shall be excavated or re-graded to allow for the addition of soil amendments and mulch. Amendments shall be uniformly spread and cultivated thoroughly by means of mechanical tiller into the top 6" of soil.
2. At time of planting, the top two inches of all areas to be planted shall be free of stones, stumps, or other deleterious matter 1" diameter or larger, and shall be free from all wire, plaster, or similar objects that would be a hindrance to planting or maintenance.

D. Final Grades:

1. Minor modifications to grade may be required to establish the final grade.
2. Finish grading shall insure proper drainage of the site as determined by the Landscape Architect. Surface drainage shall be away from all building pads.
3. All soil shall be graded so that the final grades will be 1" below adjacent paved areas, sidewalks, valve boxes, edging, concrete headers, clean-outs, drains, manholes, etc., in lawn areas top of gravel and in bed areas.
4. Eliminate all erosion scars prior to mulching and commencing

maintenance period.

E. Disposal of Excess Soil: Dispose of any unacceptable soil or debris offsite.

3.3 PLANTING INSTALLATION

A. General:
1. Actual planting shall be performed during those periods when weather and soil conditions are suitable and in accordance with locally accepted practices.
2. All planting beds shall be free of any deleterious materials, including but not limited to concrete debris, trash, buried organic material, and base material from drive and building construction.

B. Pre-Plant Weed Control:
1. Eliminate all existing bermuda grass in lawn areas by spraying with a non-selective systemic contact herbicide. Follow manufacturer's directions for applications.
2. Clear and remove existing weeds by grubbing weeds over the entire area to be planted.
3. Prior to planting install pre-emergent per manufacturer's recommendations.

C. Planting of Shade and Ornamental Trees:
1. Protect all areas from excessive compaction when trucking plants or other material to the planting site.
2. All excavated holes shall have vertical sides with roughened surfaces and shall be of a size that is twice the diameter of the rootball and the same depth as the rootball for all trees.
3. Face plants with fullest growth to most visible direction.
4. Trees shall be backfilled with:
   a. 2 parts existing soil/topsoil
   b. 1 part landscape amendment (or composted manure or peat moss)
   c. 1 part sand
   d. 1 lb. fertilizer per c.y. of mix
   e. Agriform tablets
5. All plants which settle deeper than the surrounding grade shall be raised to the correct level. Additional backfill shall be added as necessary.
6. If B&B is specified, remove any polyethylene rope from rootballs and trunks. Bend 1/3 of wire down away from trunk and rootball.
7. Tamp soil as backfilling occurs to minimize settling of soil.
8. After backfilling, an earthen basin shall be constructed around each plant. Each basin shall be 4" depth. Basins shall be constructed of amended backfill materials, or existing soil.
9. Install 4" layer of mulch at 4' diameter at each tree.
10. Pruning shall be limited to the minimum necessary to remove injured twigs and branches.
11. Install gatorbag per manufacturer's recommendations.

D. Planting of Bed Areas:
1. Soil amendments shall be added to existing soil/topsoil for bed preparation. The soil mix shall be 2" of soil amendment and 1 lb. of fertilizer per 1 c.y. of mix or 1" of peat moss, 1" sand and 1 lb. of fertilizer per 1 c.y. of mix. Install agriform tablets per manufacturer's recommendations.
2. Plants shall be grown in pots as indicated on the plans. Plants shall remain in those pots until transplanting.
3. Shrubs, perennials and groundcovers shall be planted in straight rows and

evenly space, unless otherwise noted, and at intervals called out in the drawings. Triangular spacing shall be used unless otherwise noted on the drawings.

4. Plantings shall be watered by hose after planting until the entire area is soaked to the full depth of each hole.
5. Care shall be exercised at all times to protect the plants after planting. Any damage to plants by trampling or other operations shall be repaired.

E. Installation of Lawn:

1. General:
   a. Contractor shall inspect final grade is free from ruts, uneven spots, and roughness. Final grade shall be smooth and free from large clods or debris. If this requirement is not met and lawn is installed, the grade shall be repaired to satisfaction of Landscape Architect and hydromulch or sod re-installed at no cost to Owner.
   b. Contractor is responsible for establishing a healthly and full stand of lawn of sod or seed. Contractor shall maintain lawn until established to 95% coverage in all areas and approved by Landscape Architect.
   c. Winter rye grass installation shall be considered a temporary grass application. Should Canadian Wild rye grass seed be installed, the contractor shall return to the site after March 15 to apply native grass hydroseed as called for on plans and then be responsible for establishing that grass.
   d. Disturbed areas: All areas that are disturbed due to construction operations shall be hydroseeded according to specifications. Any slopes 3:1 and greater shall be solid sodded per specifications. This will apply to areas on site whether or not identified on the plans.
2. Seeding:
   a. Apply seeded slurry with a hydraulic seeder at a rate of 2 lbs per 1000 sq. ft. evenly in two intersecting directions with following mixture:
      (1) Mixture 1 (Standard Mix):
         (a) 45#/1000 sq.ft. mulching agent
         (b) 20#/1000 sq.ft. water soluble fertilizer
      (2) Mixture 2 (for Slopes (over 6:1 or 17%) and Problem Areas):
         (a) 50#/1000 sq.ft. mulching agent
         (b) 20#/1000 sq.ft. water soluble fertilizer
         (c) .75#/1000 sq.ft. glue agent or Tackifier
   b. Do not hydroseed area in excess of that which can be mulched on same day.
   c. Immediately following seeding, apply mulch to a thickness of 1/8 inches. Maintain clear of shrubs and trees.
   d. Apply water with a fine spray immediately after each area has been mulched. Saturate to 4 inches of soil. Water to prevent grass and soil from drying out.
   e. Control growth of weeds. Apply herbicides in accordance with manufacturer's instructions. Remedy damage resulting from improper use of herbicides.
   f. Immediately reseed areas which show bare spots.
3. Sodding:
   a. Lay sod immediately after delivery to site to prevent deterioration.
   b. Lay sod tight with no open joints visible, and no overlapping; stagger end joints 12 inches minimum. Do not stretch or overlap

sod pieces.

c. Lay smooth. Align with adjoining grass areas. New finished grade and existing grade shall be flush.

d. Place top elevation of sod 1 inch below adjoining edging and curb or paving.

e. On slopes 4 inches per foot and steeper, sod shall be laid. Lay sod perpendicular to slope and secure every row with wooden pegs at maximum 2 feet on center. Drive pegs flush with soil portion of sod.

f. Prior to placing sod, on slopes exceeding 6 inches per foot or where indicated, place wire mesh over topsoil. Securely anchor in place with wood pegs sunk firmly into the ground.

g. Water sodded areas immediately after installation. Saturate sod to 4 inches of soil.

h. After sod and soil have dried, roll sodded areas to ensure good bond between sod and soil and to remove minor depressions and irregularities. Roll sodded areas with roller not exceeding 150 lbs.

4. Contractor is responsible for the establishment of lawn areas. Provide temporary irrigation as required for growth of a full stand of lawn.

a. Should construction project last longer than 20 days beyond specified finish date with any area of lawn in disrepair or in an unacceptable state to Landscape Architect, Landscape contractor shall install solid sod in sod or seed areas to complete project with no additional cost to Owner.

1. Contractor is to leave a 3 to 5 foot diameter ring around each tree, whether newly planted or existing, free of turf material. Contractor is to install 4 inches of pine bark mulch in each tree ring as specified in this section.

3.4 INSTALLATION OF MISCELLANEOUS MATERIALS

A. Mulch: All shrub, perennial, groundcover and seasonal color beds shall be dressed with 4" layer of mulch.

B. Tree stake: Install tree stakes per details. Install wire to 40-50% height of tree. Tighten wire to hold trees firmly. Do not pull wires extremely taut on trees. Install tree guards per manufacturer's recommendations. Join two tree guards together for larger caliper trees.

C. Pruning: At no time shall new trees or plant materials be pruned, trimmed or topped prior to delivery and any alteration of their shape shall be conducted only with the approval and when in the presence of the Landscape Architect.

D. Gatorbags: Install gatorbags per manufacturer's specifications and details.

E. Install steel edger 1" above finished grade. Steel edger shall be installed between all lawn and bed areas. Mulch depth shall be finish grade.

F. AREAS DISTURBED BY CONSTRUCTION

G. Recondition areas disturbed by construction operations including, but not limited to, graded areas, laydown areas, construction trailers and movement of vehicles. All compacted areas shall be tilled to 6" depth. Install 1-2" depth topsoil, rake smooth and free of any rock or other deleterious materials. Apply hydromulch seed as specified in these specifications. Solid sod all slopes 3:1 and greater. Install temporary irrigation as specified in Section 32 8423.

3.5 MAINTENANCE OF SITE (Until Final Acceptance)

A. Until final acceptance, maintain all plant materials and trees by watering, cultivating, weeding, spraying chemicals, cleaning and replacing as necessary to keep landscape in a vigorous, healthy condition. Landscape contractor is responsible for maintenance of his work whether or not existing or new irrigation system is operational. Landscape contractor is to notify the Owner and Landscape Architect for any deficiencies in the irrigation system. Failure to do so does not relieve the Landscape Contractor from replacing plant materials that have died.
   1. Watering: As necessary to keep top 2" of soil moist.
   2. Watering Trees and Shrubs: Tree and shrub rootballs are to be kept moist to the depth of the rootball.
   3. Weeding: Remove weeds and foreign grass over bed and lawn areas at least once a week. Herbicides may be used only when approved by Landscape Architect. Rake bed areas as required. Work will not be accepted with a presence of weeds in landscape.
   4. Cultivating: Cultivate bed areas to a depth of approximately 3" at least twice a month. Care should be taken not to damage plant roots.
   5. Mowing and Edging: Mow and edge newly planted lawns weekly when growth reaches 2 ½". Maintain at this height weekly.
   6. Fertilizer, Pesticides, Insecticides, and Fungicides: It is the responsibility of the contractor to insure plant material is in vigorous, healthy condition. Application of chemicals per manufacturer requirements and state and local codes is required as necessary to control any pest, insect, or fungal problems.

3.6 CLEAN UP

A. After all planting operations have been completed, remove all trash, excess soil, empty plant containers from the property. All scars, ruts or other marks in the ground caused by this work shall be repaired and the ground left in a neat and orderly condition throughout the site. Contractor shall pick up all trash resulting from his work at the end of each working day. Dispose of trash properly.

B. The Contractor shall leave the site area broom-clean and shall wash down all paved areas within the contract area, leaving the premises in a clean condition. All walks shall be left in clean and safe condition.

3.7 OBSERVATION SCHEDULE

A. The Contractor shall be responsible for notifying the Landscape Architect in advance for the following site visits.
   1. Pre-job conference
   2. Plant material review
   3. Plant layout review
   4. Soil Preparation and planting operations
   5. Final walk-through

B. No site visits shall commence without all items noted in previous Observation Reports either completed or remedied.

END OF SECTION 329300

SECTION 329301

SODDING AND SEEDING

PART 1 GENERAL

1.1 DESCRIPTION

A. Work to include:
   1. Preparation of soil, fine grading and placing of topsoil if required.
   2. Fertilizing, seeding, sod installation and maintenance.
   3. Limits of areas to be sodded and seeded are shown on plans.

B. Related work in other sections:
   1. Section 329300 Landscape Planting.

1.2 REFERENCES

A. ASPA (American Sod Producers Association) - Guideline Specifications to Sodding.

1.3 DEFINITIONS

A. Weeds: Includes Bermuda Grass, Dandelion, Jimsonweed, Quackgrass, Horsetail, Morning Glory, Rush Grass, Mustard, Lambsquarter, Chickweed, Cress, Crabgrass, Canadian Thistle Nutgrass, Poison Oak, Blackberry, Tansy Ragwort, Johnson Grass, Poison Ivy, Nut Sedge, Nimble Will, Bindweed, Bent Grass, Wild Garlic, Perennial Sorrel and Brome Grass.

1.4 QUALITY ASSURANCE

A. Sod: Sod shall have sufficient root development to support its own weight without tearing when suspended vertically by holding the upper two corners, free of weeds and undesirable grasses.

1.5 WARRANTY/ACCEPTANCE

A. Complete installation shall be guaranteed by the installer against defects of material and workmanship, for a period of thirty days, beginning with the date of substantial completion.

B. It is the responsibility of the installer to establish a dense lawn of permanent grasses as specified.

C. All sodded and seeded areas shall have no unacceptable cover. All lawn areas are to have a smooth even finished surface with no depressions, uneven areas, or open joints. Bare spots and uneven areas shall be resodded or reseeded to meet original specifications and have a new 30 day warranty.

D. Inspection: once all sodding is complete and in accordance with specifications, notify Owner's Representative for inspection. Make requested repairs, including repairing grade and topdressing joints.

1.6 MAINTENANCE SERVICE

A. Maintain installed sod and seeded areas until final acceptance. Maintenance shall include mowing, watering, fertilizing and weed treatment as specified to keep the turfgrass healthy. For seeded areas, maintain for a period of not less than 45 days after substantial completion.

PART 2 PRODUCTS

2.1 MATERIALS

A. Sod: TPI, Certified Turfgrass Sod quality; cultivated grass sod; with strong fibrous root system, rich green in color, free of stones, burned or bare spots, free of foreign grasses, weeds and nut grass; Minimum age of 2 years, with root development that will support its own weight without tearing, when suspended vertically by holding the upper two corners.
   a. Bermuda Tifway 419 (Cynodon dactylon 'Tifway 419).
   b. See 329300 Landscape planting for Native Grass Seeding by Native American Seeding or approved equal.
   b. Deliver to site on pallets. Do not stack for more than 24 hours between time of cutting and time of delivery.

B. Seed: Provide fresh, clean, new-crop seed complying with tolerance for purity and germination established by Official Seed Analysts of North America. Provide seed mixture composed of native grass species, proportions and maximum percentages of purity, germination, and minimum percentage of weed seed. See landscape planting plans for seed mixes. Native sun and shade mixes will be used as called for on landscape plans. Add jute to LID features only prior to Hydro seed and tackifier as shown on civil engineers plans and landscape plans.

PART 3 EXECUTION

3.1 INSPECTION

A. Verify that prepared soil base is ready to receive the work of this section.

B. By beginning installation, the installer accepts existing site conditions. Confirm with General Contractor that all below-ground utility work is complete.

3.2 PREPARATION

A. Scarify subsoil where topsoil is required. Repeat cultivation in areas where equipment used for hauling and spreading topsoil has compacted subsoil.

B. Place topsoil during dry weather and on dry unfrozen subgrade.

C. Remove vegetation and foreign non-organic material prior to sodding.

D. Grade to eliminate rough, low or soft areas, and to ensure positive drainage.

E. All lawn areas are to be graded to smooth to provide an even surface free of bumps and depressions, with loose uniformly fine texture and 1 1/2-2 inches below adjoining sidewalks and other paved surfaces.

3.3 FERTILIZING

A. Apply fertilizer, as indicated for sodded and seeded areas shown on plans.
B. Apply after smooth raking of topsoil and prior to installation of sod.

3.4 LAYING SOD

A. Moisten prepared surface immediately prior to laying sod. Lay sod within twenty-four (24) hours after harvesting to prevent deterioration.

B. Lay sod tight with no open joints visible and without overlapping.

C. Lay sod smooth. Place top elevation of sod level with adjoining lawn areas, edging, paving or curbs.

D. After sodding, roll with commercial lawn roller to ensure good bond between sod and soil and to remove minor depressions and irregularities.

E. Water sodded areas immediately after installation and rolling. Saturate soil to a depth of four (4) inches. Utilize automatic or temporary irrigation systems as called out for.

3.5 SEEDING

A. Hydroseeding is the acceptable seeding method. Mix specified seed, fertilizer, and pulverized mulch in water, using equipment specifically designed for hydroseeded application. Continue mixing until uniformly blended into homogenous slurry suitable for hydraulic application. Apply slurry uniformly to all areas to be seeded. Rate of application is as required by Native American Seed for sun and shade tolerant native grass and wildflower mixes and Caliche mixes or approved equal and to obtain specified seed sowing rate for various species and 95% coverage upon establishment. Add to sun and Caliche seed mixes Green Sprangletop 1 lb per 1000 sf. Do not use wet seed or seed that is moldy or otherwise damaged in transit or storage. Add only half of tackifier as typically called in hydro seed application of lawn grasses.

B. Sow seed at the following rates: as specified by Native American Seed. See Plans for native grass seed or approved equal on Landscape plans for shade areas, sun areas and LID features.

C. Protect seeded slopes of 4:1 or greater against erosion with biodegradable erosion netting or other methods acceptable to the Owner.

3.6 MAINTENANCE

A. Water to prevent grass and soil from drying out.

B. Control growth of weeds. Apply herbicides in accordance with manufacturer's instructions. Remedy damage resulting from improper use of herbicides.

C. Immediately replace sod or seed in areas which show deterioration or bare spots to establish a smooth acceptable lawn, free of eroded or bare areas. In seeded areas installer will provide 95% coverage upon acceptance. Repair eroded soil as necessary.

D. Repair or replant areas that have been damaged or trampled.

E. Mow turf when grass reaches a height of 3 1/2". Mowing height to be 2 1/2". Do not mow native seed areas.

END OF SECTION

SECTION 329345 - TREATMENT OF EXISTING TREES

PART 1 – GENERAL

1.1 SECTION INCLUDES

A. Work specified in this section: Provide all labor, materials, transportation, and services necessary to furnish tree protection fencing, tree armor, watering, pruning and fertilization to existing trees.

1.2 RELATED WORK

A. The requirements of the "General and Supplementary Conditions of the Contract" and Division 1 specification sections shall apply to all work of this Section with the same force and effect as though repeated in full herein.

1. Landscape Planting: Section 32 9300.

1.3 REFERENCES

A. AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

1.	ANSI Z60.1	(1996)	Nursery Stock.
2.	ANSI Z133.1	(1994)	Tree Care Operations- Pruning, Trimming, Repairing, Maintaining, and Removing Trees and Cutting Brush.
3.	ANSI A300	(1995)	Tree, Shrub and Other Woody Plant Maintenance- Standard Practices.

1.4 GOVERNING STANDARDS:

A. Work procedures will be guided by the current provisions of the American National Standard Institute. Complete detail of the provisions are to be found in the references listed. The two basic objectives of the pruning operation shall include:

1. Hazard Reduction Pruning: Hazard reduction pruning shall be completed to remove visible hazards in a tree. Hazard pruning shall consist of one or more of the maintenance pruning types.
2. Maintenance Pruning: Maintenance pruning shall be completed to maintain and improve tree health and structure and includes hazard reduction pruning.

B. Watering Restrictions

1. General: Follow Kendall County and Cow Creek Water Conservation District regulations.

1.5 DESCRIPTION OF WORK

A. Contractor shall employ a qualified Arborist to monitor construction activities that impact trees, pruning and feeding. Arborist is to be acceptable to the Owner's Representative.

B. Arborist shall have the following minimum qualifications:

1. Membership in:
   a. NAA - National Arborist Association
   b. ISA - International Society of Arborists
2. Meet state requirements for insurance.
3. Licensed for application and use of pesticides.
4. Bonded.

1.6 SUBMITTALS

A. Contractor shall submit:

1. Certification: Copy of Arborist qualifications.
2. Mulch: Label from bag (Supplier's statement of analysis if bulk), and 1-gallon container of mulch sample.
3. Fertilizer: Label from bag or Supplier's brochure.
4. Tree Armor: Cut sheet of wood and plywood.
5. Drip Irrigation: Cut sheet of dripline, valves, filters, air valves, and flush valves.

1.7 QUALITY ASSURANCE AND REQUIREMENTS

A. General: Comply with applicable federal, state, county, and local regulations governing, landscape materials and work.

B. Permits and Fees: The Contractors shall obtain and pay for any and all permits and all inspections as required. Contractor shall also be responsible for all fees and costs involved for work.

1. Contractor shall comply with City inspector directions with agreement from Landscape Architect without additional cost to Owner.

C. Ordinances and Regulations: All local, municipal and state laws, and rules and regulations governing or relating to any portion of this work are hereby incorporated into and made a part of these specifications, and their provisions shall be carried out by the contractor. Anything contained in these specifications shall not be construed to conflict with any of the above rules and regulations or requirements of the same. However, when these specifications and drawings call for or describe materials, workmanship, or construction of a better quality, higher standard, or larger size than is required by the above rules and regulations, the provisions of these specifications and drawings shall take precedence.

D. Personnel: Personnel shall be supervised by a Certified Arborist. Employ only experienced personnel who are familiar with the required work. Provide adequate supervision by a qualified foreman with minimum of five years experience.

1.8 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver packaged materials in containers showing weight, analysis and name of manufacturer. Protect materials from deterioration during delivery and while stored at site.

1.9 PROJECT CONDITIONS

A. Inspection: Contractor, Arborist and Owner's Representative shall review pruning work to be completed prior to initiating work.

1.10 SCHEDULES

A. The Contractor shall begin pruning and tree protection work upon acceptance of the Contract by the Owner. Arborist shall submit a schedule for the work to be performed to the Landscape Architect for approval.

1.11 PROTECTIONS

A. All items required to complete this contract remain the property and responsibility of the Contractor until final acceptance. Take adequate precautions to protect all existing trees. Cooperate fully with other trades to insure a satisfactory completion.

1.12 MAINTENANCE SERVICE

A. All existing trees to remain within shall have 6" layer of mulch at Root Protection Zone (RPZ) and to dripline and tree protection fencing properly maintained throughout construction work period.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Tree Barricade Fencing: Fabric of square link orange 4' width, high density polyethylene with 5-7 year life. Posts of 6' height studded T-posts with painted on finish for rust protection.

B. Mulch:

1. Mulch: Mulch shall be Double Shredded Native Mulch, available from New Earth Compost & Soils, 210-661-5180, Or from Solid Waste Management Department 4410 W. Piedras Dr. San Antonio TX 78228 210-207-6428 David Newman.
2. On-site existing tree mulch: Existing trees that are scheduled to be removed and removed branches may be grinded/double shredded and debris free.

C. Tree Wound Paint: Bituminous based paint of standard manufacture specifically formulated for tree wounds.

D. Fertilizer for Trees: Davey Arbor Green 30-10-7 for liquid suspended application, distributed by The Davey Company in San Antonio, Texas (210) 698-0515.

E. Tree Armor:

1. Wood: SPFA utility grade, 2x4.
2. Plywood: SPFA utility grade, 3/4" nominal thickness.
3. Wire: Annealed steel wire, 16 gage minimum.

F. Drip Irrigation:

1. Rainbird XFS dripline as manufactured by Rainbird Irrigation , Inc. distributed by Longhorn Supply, San Antonio, Texas, 210-340-3516. Contractor shall provide all necessary fittings and accessories as required by the manufacturer for the installation of the product. Drip line shall be XFS dripline, 12" o.c. emitters, 0.9 gph.
2. Valve: Rainbird pre-assembled valve, filter and pressure regulator control zone kit.
3. Pressure Regulator: Pressure Regulator shall be Low flow for valves less than 4.5 gpm and High Flow for valves greater than 4.5.
4. Air/Vacuum Relief Valve, provide one per zone.
5. Flush Valve, provide one per zone.

PART 3 - EXECUTION

3.1 PROTECTION FOR EXISTING TREES TO BE PRESERVED

A. All existing trees to remain within 30' of work on the project site shall be protected against damage from construction operations. Only remove those trees which are scheduled to be removed per plans. Contractor shall flagged tree to remain for review by Landscape Architect.

B. Contractor shall erect fencing protection prior to beginning any clearing, demolition or construction activity, maintain in place until construction is completed.

C. All trees to remain are to be protected by barricade fencing and is subject to approval of the Landscape Architect. The tree protection barricade shall be placed before any excavating or grading is begun and maintained in good repair for the duration of the construction work. No material shall be stored or construction operation shall be carried on within the tree protection barricade.

D. Trees exposed to construction activity within the dripline or within twenty-five (25) feet of any construction activity are to have trunks protected with tree armor. See requirements per tree armor section of this specification.

E. Tree protection barricade shall be erected at the edge of the dripline where possible. In circumstances where site improvements and construction operations

interfere with fencing, fencing may be located at the edge of the root protection zone. The minimum distance the barrier shall be erected is five (5) feet from the trunk of tree or clump of trees.

F. Protect trees that are to remain, whether within barricade fencing or not, from the following:
   1. Compaction of root area by equipment or material storage; construction materials shall not be stored closer to trees than the farthest extension of their limbs (dripline).
   2. No vehicular traffic shall occur within the drip line of any tree.
   3. The proposed finished grade within the root protection zone of any preserved tree shall not be raised or lowered more than three (3) inches. Retaining methods can be used to protect and/or provide lateral support to the area outside the root protection zone. No soil shall be spread, spoiled or otherwise disposed of under any tree within the drip line.
   4. Cutting on roots by excavating, ditching, etc. Prior to excavation within the tree drip lines or the removal of trees adjacent to other trees that are to remain, make a clean cut between the disturbed and undisturbed root zones with a rock saw or similar equipment to minimize root damage.
   5. Strangling by tying ropes or guy wires to trunks or large branches.
   6. Poisoning by pouring solvents, gas, paint, etc., on or around trees and roots.
   7. Trunk damage by moving equipment, material storage, nailing or bolting.
   8. Damage of branches by improper pruning.
   9. Drought from failure to water or by cutting or changing normal drainage pattern past roots. Contractor shall provide means as necessary to ensure positive drainage.
   10. Changes of soil pH factor by disposal of lime base materials such as concrete, plaster, lime treatment at pavement subgrade, etc. When installing concrete adjacent to the root zone of a tree, use a minimum 6 mil. plastic vapor barrier behind the concrete to prohibit leaching of lime into the soil.

G. Any damage done to existing tree crowns or root systems shall be repaired by the Arborist to the satisfaction of the Owner's Representative. Broken branches shall be cut cleanly. Any roots cut shall be cut cleanly with a saw other means approved by the Landscape Architect.

H. Repairs to the trees necessitated by damage caused through negligence of Contractor or his employees will be completed at the Contractor's expense. When trees other than those approved for removal are destroyed or killed, or badly damaged as a result of construction operations, the contract sum will be reduced by the value of the tree as determined by using the accepted International Society of Arboriculture's formula.

3.2 TREE ARMOR

A. Trees exposed to construction activity within the dripline or within twenty-five (25) feet of any construction activity are to have trunks protected with tree armor to a height of 8' or to the limits of the lower branching in addition to barricade fencing. Butt 2x4's side to side completely around trunk. Wire wrap, do not nail, around trees. Maintain armor the duration of construction operations.

B. Where existing trees will be Root Zone (RPZ) shall be protected by plywood. Install 6" of shredded bark mulch and cover with 3/4" plywood. Install both to dripline of tree(s).

C. Remove one week prior to Substantial Complete walk through.

3.3 ROOT PROTECTION ZONE

A. The root protection zone (RPZ) is measured with a radius from the trunk of 12" for

each caliper inch of trunk measured at four and one-half (4-1/2') feet above grade or at the point where the smallest diameter closest to the branching occurs. No disturbance shall occur closer to the tree than one-half the radius of the RPZ or within five (5) feet of the tree whichever is greater.

3.4 ROOT PROTECTION ZONE IMPACTS

A. Those trees to remain which have some encroachment on their root protection zone shall have the following maximum allowable impacts:
   1. No disturbance of natural grade, e.g. trenching or excavation, can occur closer to the tree than one-half the radius of the RPZ or within five (5) feet of the tree whichever is greater.
   2. No cut or fill greater than three (3) inches will be located closer to the tree trunk than ½ the RPZ radius distance.

B. Existing trees to remain shall have a minimum of a six (6) inch layer of mulch placed and maintained over the root protection zone and to the dripline. Immediate pruning and fertilization shall occur per the pruning and fertilization sections of this specification.

3.5 ARBORIST'S REQUIREMENTS

A. General:
   1. Arborist is to survey the condition of existing trees to remain. Notify Landscape Architect of any problems/conditions affecting the livability of trees to remain. Document site as necessary.
   2. Arborist is to install and/or inspect tree protection barriers before start of demolition and excavation activities. Notify Landscape Architect of any problems/conditions that affect the livability of trees to remain.
   3. Arborist is to observe excavation of site around existing trees from start of excavation until its conclusion. Arborist shall direct excavation which occurs near major root systems, relocation of roots, and installation of tree aeration systems as required to ensure livability and good health of trees. Arborist shall prescribe additional measures or protection required to provide optimal growth conditions at the construction site. Report any problems/conditions affecting the livability of trees to remain to Landscape Architect.
   4. Arborist shall make periodic inspections of the construction site for possibly dangerous or damaging practices, in relation to the existing trees, occurring or developing at the site. Inform Landscape Architect of any problems/conditions and develop plan to repair damage that has occurred and prevent further damage.

B. Reports:
   Arborist shall provide a monthly inspection report of the construction site to the Landscape Architect during the course of construction work.

3.6 EXCAVATION AT EXISTING TREES

A. Any excavation within the dripline of trees shall be under the direction of the Arborist. Excavate within the dripline of trees only where required and when absolutely necessary. Arborist shall be at site at all times while excavation is occurring within the dripline.

B. When excavation is required within dripline of trees, hand excavate to minimize damage to root systems. Use narrow tine spading forks and comb soil to expose roots. Relocate roots back into backfill areas wherever possible. If large main lateral roots are encountered, expose beyond excavation limits as required to bend and relocate without breaking.

C. If root relocation is not practical, clean cut roots using sharp ax approximately three (3) inches back from new construction. Paint all exposed root cuts with tree paint.

D. Where existing grade is higher than new finish grade, carefully excavate within the dripline to the new finish grade. Carefully hand excavate an additional eight (8) inches below the finish grade. Use narrow tine spading forks to comb the soil to expose the roots, and prune the exposed root structure as recommended by the Arborist. Keep the exposed roots damp by watering and mulch cover. Treat the cut roots as specified and as recommended by the Arborist. After pruning and treatment of the root structure is complete, backfill to finish grade with eight (8) inches of approved plant mix.

E. Temporarily support and protect roots against damage until permanently relocated and covered with recommended landscape material.

F. Where trenching is to occur within hitting distance of equipment to tree trunk, install tree armor per tree armor section of this specification.

G. Where removal of existing trees comes in conflict with existing hardscape/utilities to remain, the contractor shall:
   a. Coordinate with utility companies (if necessary)
   b. Remove existing tree to grade.
   c. Expose roots
   d. Use chainsaw to cut roots
   e. Grind stump 18" below grade
   f. Use trencher 2'-3' deep to cut roots if necessary.

3.7 WATERING REQUIREMENTS

A. Drought is defined as a protracted period of deficient precipitation resulting in extensive damage to plants, trees and lawn, resulting in loss.

B. During construction operations, provide water in a slow drip manner to existing trees. Provide water to apply equivalent to 1 inch once per week to deeply soak in over the area within the dripline of the tree. Spray tree crowns periodically to reduce dust accumulation on the leaves.

C. At Stage 2, 3 and 4 (Section 1.4, B. Watering Restrictions), install drip line (gallons per hour) within the dripline of the trees at grade. Install required drip valves with filters and pressure regulators with battery operated controllers. Install 6" of mulch over drip irrigation. Protect valves as required. All zones of temporary irrigation shall contain an isolation ball valve to separate from permanent irrigation system.

3.8 PRUNING

A. Pruning shall be required only at protected existing trees where the removal of limbs and branches is needed to provide clearance for work as approved by the Owner's Representative or to repair damage to trees. Pruning shall be done per 3.9 Schedule. Pruning shall be completed to the satisfaction of the Owner's Representative.

B. Pruning shall include but is not limited to removal of dead and broken branches, correction of structural defects or whenever the following conditions exist. Remove diseased wood, or structurally weak limbs that may cause a safety hazard. Remove branches that extend over buildings. Remove branches in front of windows and which obstruct traffic signs or street intersections. Provide clearance for emergency vehicles, buses, moving vans and similar vehicles along the streets. Prune trees according to their natural growth characteristics leaving trees well shaped and balanced.

C. Remove all ball moss, mistletoe, etc. from all existing trees.

3.9 PRUNING

A. Pruning shall be completed to trees within 30' of construction work. Pruning shall be done per 3.9 Schedule. Pruning shall be completed to the satisfaction of the

Owner's Representative.

B. Pruning shall include but is not limited to removal of dead and broken branches, correction of structural defects or whenever the following conditions exist. Remove diseased wood, or structurally weak limbs that may cause a safety hazard. Remove branches that extend over buildings. Remove branches in front of windows and which obstruct traffic signs or street intersections. Provide clearance for emergency vehicles, buses, moving vans and similar vehicles along the streets. Prune trees according to their natural growth characteristics leaving trees well shaped and balanced.

C. Remove all ball moss, mistletoe, etc. from all existing trees.

3.10 SCHEDULE

A. Pruning shall be Class 1 Fine Pruning. All pruning shall be completed to accomplish the thinning of live branches. Thinning shall result in an even distribution of removal of branches on individual limbs and through-out the crown. Remove dead, dying, diseased and broken branches ½" in diameter or larger within the crown. No more than 25% of the crown shall be removed.

3.1 TREE CROWN PRUNING

A. Existing trees disturbed by construction shall have a maximum of 30 percent of the viable portion of a tree's crown removed as approved by the Owner's Representative. Removal of more than 30 percent of the viable portion of a tree's crown will necessitate the tree's removal and replacement at the Contractor's expense. Replacement shall be governed at the ratio of 1 inch of new tree per inch of tree removed up to trees of size less than 24" caliper. For trees 24" caliper and greater the ratio shall be 3 inches per new tree per inch of tree removed. Replacement trees shall have permanent irrigation bubblers and a one (1) year warranty. Refer to Section 02900.

3.2 STERILIZATION: All tools used will be sterilized with alcohol between trees.

3.3 PAINT CUTS: Paint cuts more than 1 inch in diameter with an approved tree wound paint on all Oak species trees.

3.4 DISPOSAL: Wood and debris shall become property of the Contractor and shall be removed from the site. Cost of disposal to be paid by Contractor.

3.5 FERTILIZATION OF PRESERVED TREES:

A. All existing trees that have root damage shall be fertilized. Feeding of existing trees shall be as follows:

1. Feeding shall be completed prior to construction of permanent improvements adjacent to all trees including site fill or paving including trenching operations.
2. Liquid tree fertilizer applied with a standard hydrant sprayer at a pressure of 100 to 200 psi shall be injected in slightly slanted holes approximately twelve (12) inches in depth.
3. Concentration of suspension to be forty (40) pounds of fertilizer for trees in each 100 gallons of water. Application rate: six (6) pounds of actual nitrogen per 1,000 square feet of area under drip-line.
4. Holes are to be made in concentric circles and 3' on center around the tree with the last ring located at the dripline of the foliage of the trees.
5. Area beneath the dripline of the trees is to be well watered after the fertilization is placed.

3.6 MULCH:

A. Mulch base of all existing trees with 6" deep mulch layer to RPZ or dripline which ever one is larger. If existing trees are grouped, the entire area is to be mulched in between the trees.

B. If acceptable to Owner, wood from tree removal and pruning activities can be grinded/ double shredded and used on site as mulch at locations as approved by Owner's Representative. Mulch shall be less than 6" in length. All mulch shall be free of any debris.

3.7 CLEANUP:

A. Wood and debris shall become property of the Contractor and shall be removed from the site. Cost of disposal to be paid by Contractor.

END OF SECTION 329345

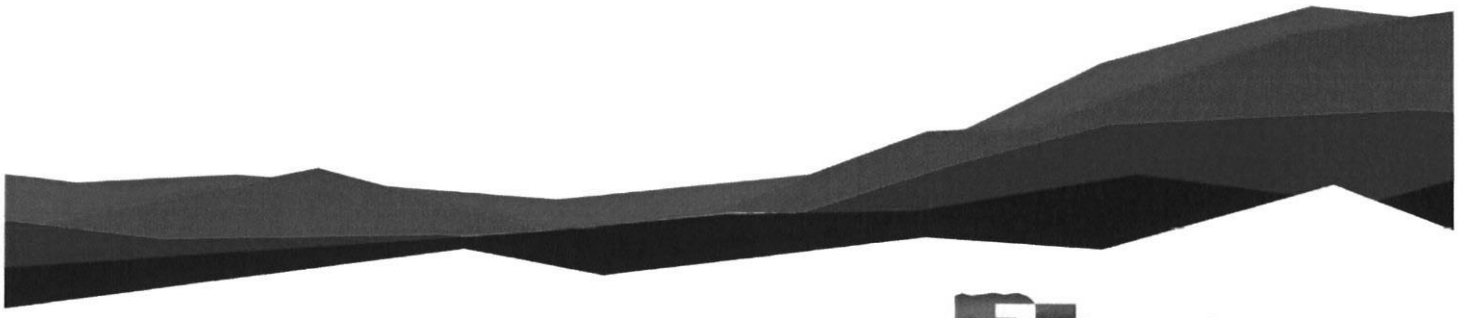
Kendall County EMS Station No. 3

Geotechnical Engineering Report

May 12, 2023 | Terracon Project No. 90235101

Prepared for:

Kendall County
201 E. San Antonio, Suite 113
Boerne, Texas 78006



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May 12, 2023

Kendall County
201 E. San Antonio, Suite 113
Boerne, Texas 78006

Attn: Mr. Richard Tobolka, P.E.
P: 806-745-9718
E: Tyler@gracorealestate.com

Re: Geotechnical Engineering Report
Kendall County EMS Station No. 3
Voss Parkway
Boerne, Texas
Terracon Project No. 90235101

Dear Mr. Tobolka:

We have completed the scope of Geotechnical Engineering services for the above referenced project in general accordance with Terracon Proposal No. P90235101, dated March 31, 2023. This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork and the design and construction of foundations and floor slabs for the proposed project.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report or if we may be of further service, please contact us.

Sincerely,

Terracon Consultants, Inc.
(Firm Registration: F3272)

Abdul K. Mohammed, PMP
Project Engineer

Arin Barkataki, P.E.
Principal

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Supporting Information

Note: This report was originally delivered in a web-based format. **Blue Bold** text in the report indicates a referenced section heading. The PDF version also includes hyperlinks which direct the reader to that section and clicking on the Terracon logo will bring you back to this page. For more interactive features, please view your project online at client.terracon.com. Refer to each individual Attachment for a listing of contents.

Report Summary

Topic [1]	Overview Statement [2]
Project Description	This geotechnical study has been performed for the Kendall County EMS Station No. 3 to be located at Voss Parkway in Boerne, Texas. The subsurface conditions at the site were explored by performing six soil borings, three to about 20 feet, one to about 10 ft and two to about 6 feet below existing grades.
Geotechnical Characterization	The subsurface materials are comprised of high plasticity Fat Clay (CH) to depths of about 2 to 4.5 feet underlain by Lean Clay and Marl below the existing site grades Groundwater was not observed in the soil borings during our exploration.
Earthwork	Excavate and remove stratum I of onsite soil from the building pad area and replace with select fill. Excavation can be stopped upon encountering Lean Clay or Marl layer. Clays are sensitive to moisture variation. The estimated Potential Vertical Rise (PVR) at this site is approximately 2 to 2½ inches.
Foundation Considerations	Shallow foundations are recommended for building support Expected settlements: < 1-inch total, < ½-inch differential
Pavements	With subgrade prepared as noted in **Earthwork**. Both asphalt and concrete pavements can be used as noted in **Pavements** Section.
General Comments	This section contains important information about the limitations of this geotechnical engineering report. This report should be provided in its entirety to the key members of the design team, namely the Architect, Civil Engineer, and Structural. In addition, the MEP engineer, the Landscape Architect, and others should be provided a copy as there may be geotechnical recommendations included herein related to their services.

1. If the reader is reviewing this report as a pdf, the topics above can be used to access the appropriate section of the report by simply clicking on the topic itself.
2. This summary is for convenience only. It should be used in conjunction with the entire report for design purposes.

Introduction

This report presents the results of our subsurface exploration and Geotechnical Engineering services performed for the Kendall County EMS Station No. 3 to be located at Voss Parkway in Boerne, Texas. The purpose of these services was to provide information and geotechnical engineering recommendations relative to:

- Subsurface soil conditions
- Groundwater conditions
- Seismic site classification per IBC
- Site preparation and earthwork
- Foundation design and construction
- Floor slab design and construction
- Pavement design and construction

The geotechnical engineering scope of services for this project included the advancement of six 6 (six) soil borings, three to about 20 feet, one to about 10 ft and two to about 6 feet below existing grades.

Drawings showing the site and boring locations are shown on the **Site Location** and **Exploration Plan**, respectively. The results of the laboratory testing performed on soil samples obtained from the site during our field exploration are included on the boring logs in the **Exploration Results** section.

Project Description

Our initial understanding of the project was provided in our proposal and was discussed during project planning. A period of collaboration has transpired since the project was initiated, and our final understanding of the project conditions is as follows:

Item	Description
Information Provided	Mr. Richard Tobolka, P.E. with Kendall County provided the following information on March 28, 2023: ■ 22-41_Sd_Ws Kendall County Ems Station No.3_Sd (Requested Boring Hole Locations).pdf
Project Description	The project consists of 6,158 GSF EMS/Sheriff Substation, with fire lanes, associated parking lots and drives.
Building Construction	The proposed building is anticipated to be wood frame or light metal frame structure and supported on slab-on-grade.

Item	Description
Finished Floor Elevation	FFE = 1383.25 +/-.
Maximum Loads	Anticipated structural loads were not provided. In the absence of information provided by the design team, we will use the following loads in estimating settlement based on our experience with similar projects. ▪ Columns: 100 kips ▪ Walls: 4 kips per linear foot (klf) ▪ Slabs: 100 pounds per square foot (psf)
Grading/Slopes	Based on the provided Site Plan, fill ranging from 1 to 4 feet will be required to establish the proposed site grades.
Below-Grade Structures	Basements are not proposed
Free-Standing Retaining Walls	Not Anticipated
Pavements	Traffic loading is anticipated to primarily include fire lane trucks, passenger vehicles, delivery truck and trash pickup truck. The pavement sections are anticipated to include asphalt and concrete sections. The pavement sections will be designed for 20 years
Building Code	2021 IBC

Terracon should be notified if any of the above information is inconsistent with the planned construction, especially the grading limits, as modifications to our recommendations may be necessary.

Site Conditions

The following description of site conditions is derived from our site visit in association with the field exploration and our review of publicly available geologic and topographic maps.

Item	Description
Parcel Information	The project is located at Voss Parkway in Boerne, Texas. Latitude/Longitude (approximate) 29.824804° N, 98.567225° W See **Site Location**
Existing Improvements	Undeveloped Vacant lot and commercial buildings on the north and west. Based on review of aerial maps from Google Earth, it is our understanding that the western part of the site had undergone some sort of earthwork operations during construction in 2018 for the adjacent development on the west.
Current Ground Cover	Oak Trees, bare soil, grass and pile of on-site soil.
Existing Topography	Based on the existing Google Earth© image and provided site grading plan the project site appears to be gently sloping with ground surface elevations ranging from about 1377 to 1382 feet.

Site Geology

Based on our review of available geologic information, the project site appears to lie within an area characterized by the Glen Rose Formation of Lower Cretaceous Age. The Glen Rose Formation limestone is comprised primarily of tan to gray limestone, dolomitic limestone, and marl in alternating hard and soft beds generally forming stair-step topography. The Glen Rose Formation is commonly overlain by a layer of variable plasticity clayey soils. Although solution cavities and voids are not very common in the Glen Rose Formation limestone, they can occur. If observed, Terracon should be contacted to evaluate the impact of the void on planned construction.

Geotechnical Characterization

We have developed a general characterization of the subsurface conditions based upon our review of the subsurface exploration, laboratory data, geologic setting and our understanding of the project. This characterization, termed GeoModel, forms the basis of our geotechnical calculations and evaluation of the site. Conditions observed at each exploration point are indicated on the individual logs. The individual logs can be found in the **Exploration Results** and the GeoModel can be found in the **Figures** attachment of this report.

As part of our analyses, we identified the following model layers within the subsurface profile. For a more detailed view of the model layer depths at each boring location, refer to the GeoModel.

Model Layer/Stratum	Layer Name	General Description
1/I	Fat Clay (CH)[1]	Brown, medium stiff to very stiff, with varying amounts of sand
2/II	Lean Clay with Sand (CL)[2]	Brown to tan, very stiff to hard
3/III	Marl[3]	Tan, hard

1. The FAT CLAY (CH) materials could undergo moderate to high volumetric changes (shrink/swell) should they experience changes in their in-place moisture content.
2. The native LEAN CLAY (CL) materials could undergo moderate volumetric changes (shrink/swell) should they experience changes in their in-place moisture content
3. The native MARL is defined in ASTM D 653-90 Standard Terminology Relating to Soil, Rock and Contained Fluids as" calcareous clay usually containing from 35 to 65 percent calcium carbonate." The calcium carbonate is an indication of a cemented matrix of sand, silt or clay. When submerged in water, marl will begin to slake. ***However, when being excavated or drilled this material typically behaves more like a rock than soil thereby requiring construction equipment and procedures typically used for rock.***

Groundwater Conditions

Groundwater water generally appears as either a permanent or temporary water source. Permanent subsurface water is generally present year-round, which may or may not be influenced by seasonal and climatic changes. Temporary groundwater water is also referred to as a "perched" water source, which generally develops as a result of seasonal and climatic conditions.

The boreholes were observed while drilling and after completion for the presence and level of groundwater. Groundwater was not observed during drilling. The borings were backfilled with soil cuttings after the drilling operations were completed. Groundwater levels are influenced by seasonal and climatic conditions which generally result in fluctuations in the elevation of the groundwater level over time. Therefore, the foundation contractor should check the groundwater conditions just before foundation excavation activities.

Seismic Site Class

The seismic design requirements for buildings and other structures are based on Seismic Design Category. Site Classification is required to determine the Seismic Design Category for a structure. The Site Classification is based on the upper 100 feet of the site profile defined by a weighted average value of either shear wave velocity, standard penetration resistance, or undrained shear strength in accordance with Section 20.4 of ASCE 7 and the International Building Code (IBC). Based on the soil properties observed at the site and as described on the exploration logs and results, our professional opinion is for that a **Seismic Site Classification of C** be considered for the project. Subsurface explorations at this site were extended to a maximum depth of 20 feet. The site properties below the boring depth to 100 feet were estimated based on our experience and knowledge of geologic conditions of the general area. Additional deeper borings or geophysical testing may be performed to confirm the conditions below the current boring depth.

Sulfate Considerations

Sulfate tests were performed on selected soil samples collected from the project site to check for a possible adverse reaction with concrete. Testing was not performed on all borings nor at all depths.

Sulfate content concentrations for some of the borings along with their location and approximate depth are as follow:

Boring	Sample Depth (feet)	Soil Description	Sulfate Content (ppm)
B-1	2.5-4	Fat Clay (CH)	136
B-3	4.5-6	Marl (CL)	34
P-2	0-1.5	Fat Clay (CH)	70.6

Based on the test results, the sulfate effect at this site may be considered as low. The test results indicate that the sulfate concentrations in the soils are within levels deemed to be of a low risk for adverse reactions when mixed with a calcium based additive TxDOT (>8,000 ppm), the National Lime Association (>3,000 ppm) and AASHTO (>5,000 ppm). The American Concrete Institute (ACI) and the Texas Department of Transportation (TxDOT) provide guidance and specifications regarding sulfates in soil and groundwater.

The severity of potential exposure of concrete to sulfate attack falls under Class 0 to 1.

Water Soluble Sulfate Content in Soil (mg/kg)	Severity of Potential Exposure
> 10,000	Class 3
1,500 – 10,000	Class 2
150 – 1,500	Class 1
0 – 150	Class 0

Geotechnical Overview

The site appears suitable for the proposed construction based upon geotechnical conditions encountered in the test boring, provided that the recommendations in this report are implemented in the design and construction phases of this project. The subsurface materials comprised of high plasticity Fat Clay (CH) to depths of about 2.5 to 4.5 feet underlain by Lean Clay and Marl until the termination depths.

Based on the conditions encountered and estimated load-settlement relationships, the proposed structure can be supported on a conventional shallow foundations system. The **Shallow Foundations** section addresses support of the structure directly bearing on prepared native soils or engineered fill.

The foundations being considered to provide support for the planned structure must satisfy two independent engineering criteria with respect to the subsurface conditions encountered at this site. One criterion is the foundation system must be designed with an appropriate factor of safety to reduce the possibility of a bearing capacity failure of the soils underlying the foundation. The other criterion is movement of the foundation system due to compression (consolidation or shrinkage) or expansion (swell) of the underlying soils must be within tolerable limits for the structure.

The suitability and performance of a soil supported foundation for a structure depends on many factors including the magnitude of soil movement expected, the type of structure, the intended use of the structure, the construction methods available to stabilize the soils, and our understanding of the owner's expectations of the completed structure's performance.

The recommendations contained in this report are based upon the results of field and laboratory testing (presented in the **Exploration Results**), engineering analyses, and our current understanding of the proposed project. The **General Comments** section provides an understanding of the report limitations.

Expansion Potential

Expansive soils are present at this site. The near surface, high plasticity fat clay could become unstable with typical earthwork and construction traffic, especially after precipitation events. Effective drainage should be completed early in the construction sequence and maintained after construction to avoid potential issues. If possible, the grading should be performed during the warmer and drier times of the year. If grading is performed during the winter months, an increased risk for possible undercutting and replacement of unstable subgrade will persist. Additional site preparation recommendations, including subgrade improvement and fill placement, are provided in the **Earthwork** section.

Based on our findings, the subsurface soils at this site generally exhibit high shrink/swell potential. Based on the information developed from our field and laboratory programs and on method TEX-124-E of the Texas Department of Transportation (TxDOT) Manual of Testing Procedures, we estimate that the subgrade soils at this site exhibit a Potential Vertical Rise (PVR) of about 2 to 2½ inches in their present condition. It must be emphasized that the actual movements could be greater than the values presented in this report because of inadequate drainage, ponded water and moisture infiltration beneath the structures after construction.

Site grades should provide effective drainage away from the structure during and after construction. Water permitted to pond next to the structure can result in greater soil movements than those discussed in this report. These greater movements can result in unacceptable differential floor slab movements, cracked slabs and walls, and roof leaks. Estimated movements described in this report are based on effective drainage for the life of the structure and cannot be relied upon if effective drainage is not maintained. Recommendations for preparing the building pad to reduce soil movements are provided in the **Building Pad Preparation** section of this report. Proper water management is important. Recommendations regarding this issue are included in the **Grading and Drainage** section of this report.

Earthwork

Earthwork is anticipated to include, clearing and grubbing, excavations, and engineered fill placement. The following sections provide recommendations for use in the preparation of specifications for the work. Recommendations include critical quality criteria, as necessary, to render the site in the state considered in our geotechnical engineering evaluation for foundations, and floor slabs.

Site Preparation

Construction operations may encounter difficulties due to the wet or soft surface soils becoming a general hindrance to equipment due to rutting and pumping of the soil surface, especially during and soon after periods of wet weather. If the subgrade cannot be adequately compacted to minimum densities as described in the **Compaction Requirements** section of this report, one of the following measures may be required:

- removal and replacement with select fill;
- chemical treatment of the soil to dry and increase the stability of the subgrade; or
- drying by natural means if the schedule allows.

It is the responsibility of the contractor to choose the method required to access the site.

In our experience with similar soils in this area, chemical treatment (hydrated lime or cement) may be an effective method to increase the supporting value of wet and weak subgrade. Terracon should be contacted for additional recommendations if chemical treatment of the soils is needed.

Prior to construction, any vegetation, loose topsoil as necessary and any otherwise unsuitable materials should be removed from the construction area. The stripped materials consisting of vegetation and organic materials should be wasted from the site or used to revegetate landscaped areas or exposed slopes after completion of grading operations. Wet or dry material should either be removed, or moisture conditioned and recompacted. After stripping and grubbing, the subgrade should be proof rolled where possible to aid in locating loose or soft areas. Proof-rolling can be performed with a 20-ton roller or fully loaded dump truck. Soils that are observed to rut or deflect excessively (typically greater than 1-inch) under the moving load should be undercut and replaced with properly compacted soils. The proof-rolling and undercutting activities should be witnessed by a representative of the geotechnical engineer and should be performed during a period of dry weather.

After proofrolling, and just prior to placement of fill, the exposed subgrade within the construction areas should be evaluated for moisture and density. If the moisture, density, and/or the requirements do not meet the criteria described in the table below, the subgrade should be scarified to a minimum depth of 8 inches, moisture adjusted and compacted to at least 95 percent of the Standard Effort (ASTM D 698) maximum dry density.

Building Pad Preparation

The following building pad preparation recommendations should be performed for the proposed building prior to foundation construction. The existing PVR at this site in present conditions is about 2 to 2½ inches. Recommendations for at-grade pad preparation to

reduce the PVR to about 1 inch and to provide uniform support to the grade supported slabs and flatwork for this project site are provided in the following sections.

The FFE for the building is set at 1383.25 +/- feet. Assuming a 6-inch building slab, the Finished Building Pad Elevation (FBPE) is about 1382.5 feet. Recommendations for preparation of the building pad are as follows

- After completing stripping operations discussed in the **Site Preparation** section, excavate and remove (Stratum I) onsite fat clay (CH) soils i.e., stratum I below the finished building pad area. If the Stratum II /III Lean Clay or Marl is exposed, excavation can stop. The building pad area is defined as the area that extends at least 5 feet (horizontal) beyond the perimeter of the proposed buildings and any adjacent flatwork. The limits of the building pad should be indicated on the drawings for the project.

Finished Floor Elevation (feet)	Existing Grade Elevation (feet)	Finished Building Pad Elevation (FBPE), (feet)	Excavation Elevation (feet) [1]	Thickness of Select Fill Soil (feet)
1383.25	1379 to 1380	1382.75	1374.5-1377.5	About 5.25 to 8

1. Excavation may stop upon encountering layer II/III.

- After removing the near-surface on-site soils, the exposed subgrade in the pad should be proof rolled with at least a fully loaded dump truck or equivalent pneumatic tired vehicle to evidence any weak yielding zones. A Terracon geotechnical engineer or their representative should be present to observe proof rolling operations.

- Over-excavate any confirmed weak yielding zones, both vertically and horizontally, to expose competent soil. The upper 6 inches of the exposed subgrade should be moisture conditioned between -2 and +3 percentage points of the optimum moisture content and then compact to at least 95 percent of the maximum dry density determined in accordance with ASTM D698.

- After proof-rolling and the replacement of weak yielding zones, imported select fill should be used to achieve the Finished Building Pad Elevation (FBPE) of about 1382.75 feet. Imported select fill should be placed in loose lifts of about 8 inches and compacted thickness not exceeding 6 inches, moisture conditioned between -2 and +3 percentage points of the optimum moisture content and then compact to at least 95 percent of the maximum dry density determined in accordance with ASTM D698.

- To provide a more uniform slab support and create a more all-weather working surface, we recommend constructing the final 6 inches of the pad with granular select fill.

Fill Material Types

Fill required to achieve design grade should be classified as structural fill (select fill) and general fill. Structural fill is material used below, or within 3 feet of structures. General fill is material used to achieve grade outside of these areas.

Soil Type [1]	USCS Classification	Acceptable Parameters
Select fill	CL, GC, SC ▪ LL≤40 and 5<PI≤20 ▪ % passing #200 sieve ≥35% ▪ Maximum particle size 3"	All locations and elevations.
On-Site Soil	CH, CL, Marl	On-site CH soil is not suitable for use as select fill, but can be used in pavement and landscaping areas. Onsite CL and Marl soil may be used as select fill provided, they are tested and meet the criteria of select fill prior to use.
Granular Select Fill[2]	Varies	Upper 6 inches of the pad can be used directly beneath the floor slab as working surface

1. Prior to any filling operations, samples of the proposed borrow and on-site materials should be obtained for laboratory moisture-density testing. The tests will provide a basis for evaluation of fill compaction by in-place density testing. A qualified soil technician should perform sufficient in-place density tests during the filling operations to evaluate that proper levels of compaction, including dry unit weight and moisture content, are being attained.
2. Granular select fill should consist of 2014 TxDOT Item 247, Type A, Grade 1-2 crushed limestone base material. Plasticity Index ranging from 5 to 15.

Fill Placement and Compaction Requirements

Select and general fill should meet the following compaction requirements.

Item	Requirements
Fill Lift Thickness	All fill should be placed in thin, loose lifts of about 8 inches, with compacted thickness not exceeding 6 inches.
Compaction of On-Site Soil, Select Fill and Granular Select Fill	95 percent of the material's Standard Proctor maximum dry density (ASTM D 698).
Water Content Range [1]	The materials should be moisture conditioned between -2 and +3 percentage points of the optimum moisture content

Utility Trench Backfill

Any soft or unsuitable materials encountered at the bottom of utility trench excavations should be removed and replaced with structural fill or bedding material in accordance with public works specifications for the utility be supported. This recommendation is particularly applicable to utility work requiring grade control and/or in areas where subsequent grade raising could cause settlement in the subgrade supporting the utility. Trench excavation should not be conducted below a downward 1:1 projection from existing foundations without engineering review of shoring requirements and geotechnical observation during construction.

On-site materials are considered suitable for backfill of utility and pipe trenches from 1 foot above the top of the pipe to the final ground surface, provided the material is free of organic matter and deleterious substances.

Trench backfill should be mechanically placed and compacted as discussed earlier in this report. Compaction of initial lifts should be accomplished with hand-operated tampers or other lightweight compactors. Where trenches are placed beneath slabs or footings, the backfill should satisfy the gradation and expansion index requirements of engineered fill discussed in this report. Flooding or jetting for placement and compaction of backfill is not recommended.

For low permeability subgrades, utility trenches are a common source of water infiltration and migration. Utility trenches penetrating beneath the building should be effectively sealed to restrict water intrusion and flow through the trenches, which could migrate below the building. The trench should provide an effective trench plug that extends at least 5 feet from the face of the building exterior. The plug material should consist of cementitious flowable fill or low permeability clay. The trench plug material should be placed to surround the utility line. If used, the clay trench plug material should be placed and compacted to comply with the water content and compaction recommendations for structural fill stated previously in this report.

Grading and Drainage

All grades must provide effective drainage away from the building during and after construction and should be maintained throughout the life of the structure. Water retained next to the building can result in soil movements greater than those discussed in this report. Greater movements can result in unacceptable differential floor slab and/or foundation movements, cracked slabs and walls, and roof leaks. The roof should have gutters/drains with downspouts that discharge onto splash blocks at a distance of at least 10 feet from the building.

Exposed ground should be sloped and maintained at a minimum 5% away from the building for at least 10 feet beyond the perimeter of the building. Locally, flatter grades may be necessary to transition ADA access requirements for flatwork. After building construction and landscaping have been completed, final grades should be verified to document effective drainage has been achieved. Grades around the structure should also be periodically inspected and adjusted, as necessary, as part of the structure's maintenance program. Where paving or flatwork abuts the structure, a maintenance program should be established to effectively seal and maintain joints and prevent surface water infiltration.

Earthwork Construction Considerations

Shallow excavations for the proposed structure are anticipated to be accomplished with conventional construction equipment. If excavation penetrates into Layer III Marl, heavy duty excavation equipment will be required. Upon completion of filling and grading, care should be taken to maintain the subgrade water content prior to construction of grade-supported improvements such as floor slabs. Construction traffic over the completed subgrades should be avoided. The site should also be graded to prevent ponding of surface water on the prepared subgrades or in excavations. Water collecting over or adjacent to construction areas should be removed. If the subgrade desiccates, saturates, or is disturbed, the affected material should be removed, or the materials should be scarified, moisture conditioned, and recompacted prior to floor slab construction.

As a minimum, excavations should be performed in accordance with OSHA 29 CFR, Part 1926, Subpart P, "Excavations" and its appendices, and in accordance with any applicable local and/or state regulations.

Construction site safety is the sole responsibility of the contractor who controls the means, methods, and sequencing of construction operations. Under no circumstances shall the information provided herein be interpreted to mean Terracon is assuming responsibility for construction site safety or the contractor's activities; such responsibility shall neither be implied nor inferred.

Construction Observation and Testing

The earthwork efforts should be observed by the Geotechnical Engineer (or others under their direction). Observation should include documentation of adequate removal of surficial materials (vegetation, topsoil, and pavements), evaluation and remediation of existing fill materials, as well as proofrolling and mitigation of unsuitable areas delineated by the proofroll.

Each lift of compacted fill should be tested, evaluated, and reworked, as necessary, as recommended by the Geotechnical Engineer prior to placement of additional lifts. Each lift of fill should be tested for density and water content at a frequency of at least one test for every 2,500 square feet of compacted fill in the building areas and 5,000 square feet in pavement areas. Where not specified by local ordinance, one density and water content test should be performed for every 100 linear feet of compacted utility trench backfill and a minimum of one test performed for every 12 vertical inches of compacted backfill.

In areas of foundation excavations, the bearing subgrade should be evaluated by the Geotechnical Engineer. If unanticipated conditions are observed, the Geotechnical Engineer should prescribe mitigation options.

In addition to the documentation of the essential parameters necessary for construction, the continuation of the Geotechnical Engineer into the construction phase of the project provides the continuity to maintain the Geotechnical Engineer's evaluation of subsurface conditions, including assessing variations and associated design changes.

Shallow Foundations

Slab on Grade

A monolithic slab-on-grade foundation with perimeter grade beam foundation may be considered to support the structures at this site provided the building pad is prepared as recommended in this report. Design parameters presented in the table below are based on our understanding of the proposed project, our interpretation of the information and data collected as a part of this study.

Conventional Method Parameters	**Value**
Net Allowable Bearing Pressures [1]	2,000 psf
Subgrade Modulus (k)	100 pci
Potential Vertical Rise (PVR)	1 inch
WRI Method Parameters	
Effective Plasticity Index (PI) [2]	21
Climatic Rating (Cw)	17
Soil – Climate Support Index (I_c)	0.05
PTI Method 3rd Edition	
Thornthwaite Moisture Index (I_m)	-16
Depth of Constant Soil Suction	5 feet
Constant Soil Suction	3.6 pF
Edge Moisture Variation Distance (e_m):	
Center Lift	8.7 feet
Edge Lift	4.5 feet
Differential Soil Movement (y_m):	
Center Lift	-0.94 inches
Edge Lift	1.45 inches
Coefficient of Slab-Subgrade Friction (μ):	0.75 to 1.00

1. The net allowable bearing pressure provided above includes a Factor of Safety (FS) of at least 3. Based on building pad preparation recommended in this report.
2. The WRI effective PI is the weighted average of the PI values in the upper 15 feet of the soil profile. The upper 5 feet has a weight factor of 3; the depth range from 5 to 10 feet has a weight factor of 2; the depth range of 10 to 15 feet has a weight factor of 1.

We recommend that exterior grade beams be at least 30 inches below the finished exterior grade. Interior grade beams (if any) should bear at least 24 inches below the FFE. These recommendations are for a proper development of bearing capacity for the continuous beam sections of the foundation system and to reduce the potential for water to migrate beneath the slab foundation. These recommendations are not based on structural considerations. Grade beam depths may need to be greater than recommended herein for structural considerations and should be properly evaluated and designed by the Structural Engineer. The grade beams or slab portions may be thickened and widened to serve as spread footings at concentrated load areas.

For a slab on grade foundation system designed and constructed as recommended in this report, post construction consolidation settlements should be less than 1 inch. Settlement response of a slab on grade foundation is influenced more by the quality of construction than by soil-structure interaction. Therefore, it is essential that the recommendations for foundation construction be strictly followed during the construction phases of the pad and foundation.

The use of a vapor retarder should be considered beneath concrete slabs-on-grade that will be covered with wood, tile, carpet or other moisture sensitive or impervious coverings, or when the slabs will support equipment sensitive to moisture. When conditions warrant the use of a vapor retarder, the slab designer and slab contractor should refer to ACI 302 for procedures and cautions about the use and placement of a vapor retarder.

Slab-on-Grade Construction Considerations

The grade beams should preferably be neat excavated. Excavation through the native Stratum I and II soils and the select fill pad may be accomplished with conventional equipment. Excavation of the underlying Marl may be accomplished by use of heavy duty or rock excavation equipment. Debris in the bottom of the excavation should be removed prior to steel placement.

To reduce the potential for water infiltration into the excavations and to minimize disturbance to the bearing area, we recommend that concrete and steel be placed as soon as possible after the excavations are completed. Excavations should not be left open for a prolonged period of time. The bearing surface of the grade beams should be evaluated after excavation is completed and immediately prior to placing concrete. If not, a seal slab consisting of lean concrete should be poured to protect the exposed bearing surface. The bearing surface should be excavated with a slight slope to create an internal sump for runoff water collection and removal. If surface runoff water in excess of 1 inch accumulates at the bottom of the excavation, it should be pumped out prior to concrete placement. Under no circumstances should water be allowed to adversely affect the quality of the bearing surface.

Spread Footings

Item	Description
Maximum Net Allowable Bearing Pressure [1, 2]	Select fill– 2,500 psf
Required Bearing Stratum [3]	select fill
Minimum Foundation Dimensions	30 inches from finished grade
Ultimate Passive Resistance[4] **(equivalent fluid pressures)**	400 psf
Sliding Resistance [5]	0.30 ultimate coefficient of friction
Minimum Embedment below Finished Grade	Exterior footings: 36 inches Interior footings: 30 inches
Estimated Total Settlement from Structural Loads [2]	About 1 inch
Estimated Differential Settlement [2, 6]	About ½ of total settlement

1. **The maximum net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation. The net allowable bearing pressure provided above include a factor of safety of at least 3.**
2. **Values provided are for maximum loads noted in** Project Description**. Additional geotechnical consultation will be necessary if higher loads are anticipated.**
3. **Unsuitable or soft soils should be overexcavated and replaced per the recommendations presented in** Earthwork**.**
4. **Use of passive earth pressures require the sides of the excavation for the spread footing foundation to be nearly vertical and the concrete placed neat against these vertical faces or that the footing forms be removed, and compacted structural fill be placed against the vertical footing face. Assumes no hydrostatic pressure. The passive pressure provided above include a factor of safety of at least 2.**
5. **Can be used to compute sliding resistance where foundations are placed on suitable soil/materials. Frictional resistance for granular materials is dependent on the bearing pressure which may vary due to load combinations. For fine-grained materials, lateral resistance using cohesion should not exceed ½ the dead load.**
6. **Differential settlements are noted for equivalent-loaded foundations and bearing elevation as measured over a span of 50 feet.**

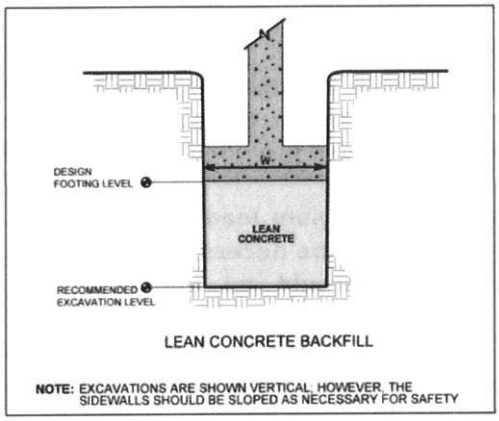
Spread Footings Construction Considerations

As noted in **Earthwork**, the footing excavations should be evaluated under the observation of the Geotechnical Engineer. The base of all foundation excavations should be free of water and loose soil, prior to placing concrete. Concrete should be placed soon after excavating to reduce bearing soil disturbance. Care should be taken to prevent wetting or drying of the bearing materials during construction. Excessively wet or dry

material or any loose/disturbed material in the bottom of the footing excavations should be removed/reconditioned before foundation concrete is placed.

Sensitive soils exposed at the surface of footing excavations may require surficial compaction with hand-held dynamic compaction equipment prior to placing structural fill, steel, and/or concrete. Should surficial compaction not be adequate, construction of a working surface consisting of either crushed stone or a lean concrete mud mat may be required prior to the placement of reinforcing steel and construction of foundations.

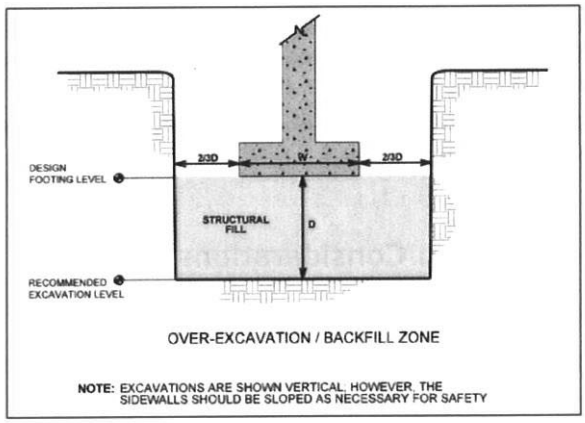
If unsuitable bearing soils are observed at the base of the planned footing excavation, the excavation should be extended deeper to suitable soils, and the footings could bear directly on these soils at the lower level or on lean concrete backfill placed in the excavations. The lean concrete replacement zone is illustrated on the sketch below.



LEAN CONCRETE BACKFILL

NOTE: EXCAVATIONS ARE SHOWN VERTICAL, HOWEVER, THE SIDEWALLS SHOULD BE SLOPED AS NECESSARY FOR SAFETY

Overexcavation for structural fill placement below footings should be conducted as shown below. The overexcavation should be backfilled up to the footing base elevation, with imported fill placed, as recommended in the **Earthwork** section.



OVER-EXCAVATION / BACKFILL ZONE

NOTE: EXCAVATIONS ARE SHOWN VERTICAL, HOWEVER, THE SIDEWALLS SHOULD BE SLOPED AS NECESSARY FOR SAFETY

Flatwork

Grade-supported flatwork, or sidewalks, adjacent to the building will be subject to the movements unless proper measures are taken. Differential movement between the flatwork and building slab may result in a trip hazard. Doweling the flatwork to the foundation at common openings will help limit differential movements and trip hazards. Heaving of the soils beneath the flatwork may also change drainage patterns and direct water towards the buildings. The flatwork can be prepared as the building pad if performance of the flatwork similar to the building is desired as recommended. All joints in the flatwork surrounding the structure should be kept sealed and properly maintained.

The flatwork immediately adjacent to the structures should be sloped as much as possible to maintain positive drainage away from the structure. If measures are not taken to address differential movement in the design stage, this issue may become a constant maintenance issue during the life of the building.

Pavements

Both flexible and rigid pavement systems may be considered for the project. Based on our knowledge of the project, we anticipate that traffic loads will be produced primarily by automobile traffic, fire trucks, EMS ambulances and occasional trash removal trucks.

Pavement Subgrade Preparations

Prior to construction, any vegetation, and any otherwise unsuitable materials should be removed from the new pavement areas. After stripping, the subgrade should be proof rolled where possible to aid in locating loose or soft areas. Proof-rolling can be performed with a 15-ton roller or fully loaded dump truck. Wet, soft, low-density or dry material should either be removed, or moisture conditioned and recompacted to the moisture contents and densities described in section **Compaction Requirements** prior to placing fill. Pavement constructed on possible fill may be experience excessive settlement and cracking unless the recommendations for proofroll and removal of soft/loose materials are followed as presented in this section. With these recommendations pavement may still experience movement up to 2½-inches and some distress will occur, unless the pavement subgrade is prepared as the building pad.

Pavement Design Considerations

Traffic loads will be produced primarily by automobile traffic, fire trucks, EMS ambulances and occasional trash removal trucks. For this project Light and Heavy pavement section alternatives have been provided. Light is for areas expected to receive only car traffic. Heavy assumes areas with heavy traffic, such as fire trucks, EMS ambulances, trash pickup

areas and main access drive areas.

The flexible pavement section was designed in general accordance with the National Asphalt Pavement Association (NAPA) Information Series (IS-109) method (Class 1 for Light and Class 2 for Heavy). The rigid pavement section was designed using the American Concrete Institute (ACI 330R-01) method (Traffic Category A (ADTT=0) for Light and A-1 (ADTT=10) for Heavy). If heavier traffic loading is expected, Terracon should be provided with the information and allowed to review these pavement sections.

The following table provides our estimated minimum thickness of flexible pavements

Flexible Pavement Design

Layer	Minimum Recommended Flexible Pavement Section Thickness [1]			
	Raw Subgrade		Modified Subgrade	
	Light Duty (inch)	Heavy Duty (inch)	Light Duty (inch)	Heavy Duty (inch)
Hot Mix Asphaltic Concrete	2.0	3.0	2.0	3.0
Granular Base Material [1,2]	10.0	12.0	6.0	8.0
Moisture Conditioned Subgrade[3]	6.0	6.0	---	---
Modified Subgrade (Lime treated)	---	---	6.0	6.0

1. Flexible pavement is not recommended in the fire truck travel paths and main access drive.
2. Asphaltic base material may be used in place of granular base material. Every 2.5 inches of granular base material may be replaced with 1 inch of asphaltic base material. However, the minimum thickness of the asphaltic base material is 4 inches.
3. A geogrid like TX-140 can be used to reduce the base thickness by about 4 inches. However, the minimum base thickness is 6 inches.

The following table provides our estimated minimum thickness of rigid pavements

Rigid Pavement Design

Layer	Minimum Recommended Rigid Pavement Section Thickness			
	Light Duty (inch)	Heavy Duty (inch)	Light Duty (inch)	Heavy Duty (inch)
Reinforced Concrete	6.0	7.5	5.5	7.0
Moisture Conditioned Subgrade	6.0	6.0	---	---
Modified Subgrade (Lime Treated)	---	---	6.0	6.0

Pavement areas that will be subjected to heavy wheel and traffic volumes, such as fire trucks, EMS ambulances, waste bin or "dumpster" areas, entrance/exit

ramps, and delivery areas, should be a rigid pavement section constructed of reinforced concrete

Pavement areas that will be subjected to heavy wheel and traffic volumes, such as waste bin or "dumpster" areas, entrance/exit ramps, and delivery areas, should be a rigid pavement section constructed of reinforced concrete. The concrete pavement areas should be large enough to properly accommodate the vehicular traffic and loads. For example:

- The dumpster pad should be large enough so that the wheels of the collection truck are entirely supported on the concrete pavement during lifting of the waste bin; and
- The concrete pavement should extend beyond any areas that require extensive turning, stopping, and maneuvering.

The pavement design engineer should consider these and other similar situations when planning and designing pavement areas. Waste bin and other areas that are not designed to accommodate these situations often result in localized pavement failures.

The pavement section has been designed using generally recognized structural coefficients for the pavement materials. These structural coefficients reflect the relative strength of the pavement materials and their contribution to the structural integrity of the pavement. If the pavement does not drain properly, it is likely that ponded water will infiltrate the pavement materials resulting in a weakening of the materials. As a result, the structural coefficients of the pavement materials will be reduced, and the life and performance of the pavement will be shortened. The Asphalt Institute recommends a minimum of 2 percent slope for asphalt pavements. The importance of proper drainage cannot be overemphasized and should be thoroughly considered by the project team.

Pavement Section Materials

Presented below are selection and preparation guidelines for various materials that may be used to construct the pavement sections. Submittals should be made for each pavement material. The submittals should be reviewed by the Geotechnical Engineer and appropriate members of the design team and should provide test information necessary to verify full compliance with the recommended or specified material properties.

- **Hot Mix Asphaltic Concrete Surface Course -** The asphaltic concrete surface course should be plant mixed, hot laid Type C or D Surface. The asphaltic concrete base course should also be plant mixed, hot laid Type A or B. Each mix should meet the master specifications requirements of 2014 TxDOT Standard Specifications Item 3076, Item SS 3224 (2011) and specific criteria for the job mix formula. The mix should be compacted between 91 and 95 percent of the maximum theoretical density as measured by TEX-227-F. The asphalt cement content by percent of total mixture weight should

fall within a tolerance of ±0.3 percent asphalt cement from the specific mix. In addition, the mix should be designed so 75 to 85 percent of the voids in the mineral aggregate (VMA) are filled with asphalt cement. The grade of the asphalt cement should be PG 70-22 or higher performance grade. Aggregates known to be prone to stripping should not be used in the hot mix. If such aggregates are used measures should be taken to mitigate this concern. The mix should have at least 70 percent strength retention when tested in accordance with TEX-531-C.

Pavement specimens, which shall be either cores or sections of asphaltic pavement, will be tested according to Test Method TEX-207-F. The nuclear-density gauge or other methods which correlate satisfactorily with results obtained from project pavement specimens may be used when approved by the Engineer. Unless otherwise shown on the plans, the Contractor shall be responsible for obtaining the required pavement specimens at their expense and in a manner and at locations selected by the Engineer.

- **Concrete -** Concrete should have a minimum 28-day design compressive strength of 4,000 psi.

- **Granular Base Material** Base material may be composed of crushed limestone base meeting all of the requirements of 2014 TxDOT Item 247, Type A, Grade 1-2; including triaxial strength. The material should be compacted to at least 95 percent of the maximum dry density as determined in accordance with ASTM D 1557 at moisture contents ranging from -2 and +3 percentage points of the optimum moisture content.

- **Modified Subgrade** - Due to the presence of clay at this site, the subgrade may be modified with hydrated lime in accordance with TxDOT Item 260 in order to improve its strength and improve its load carrying capacity. We anticipate that approximately 6 percent hydrated lime will be required. This is equivalent to about 30 pounds of hydrated lime per square yard for a 6-inch treatment depth. However, the actual percentage should be determined by laboratory tests on samples of the clayey subgrade prior to construction. The optimum lime content should result in a soil-lime mixture with a pH of at least 12.4 when tested in accordance with ASTM C 977, Appendix XI and should reduce the Plasticity Index to 20 or less.

  The lime should initially be blended with a mixing device such as a Pulvermixer, sufficient water added, and be allowed to cure for at least 48 hours. After curing, the lime-soil should be remixed to meet the in-place gradation requirements of Item 260 and compacted to at least 95 percent of the maximum dry density determined in accordance with ASTM D 698 at

moisture contents ranging from optimum and 4 percentage points above the optimum moisture content.

- **Moisture Conditioned Subgrade -** The subgrade should be scarified to a depth of 6 inches and then moisture conditioned and compacted as recommended in the **Compaction Requirements** section of this report.

Details regarding subgrade preparation, fill materials, placement and compaction are presented in **Earthwork** section under subsections **Fill Materials Requirement** and **Compaction Requirements**.

Pavement Joints and Reinforcement

The following is recommended for all concrete pavement sections in this report. Refer to ACI 330 "Guide for Design and Construction of Concrete Parking Lots" and "TxDOT Standard Specifications" for additional information.

Item	Description
Reinforcing Steel	No 3 reinforcing steel bars at 18 inches on-center-each-way, Grade 60. It is imperative that the distributed steel be positioned accurately in the pavement cross section, namely 2 inches from the top of the pavement.
Contraction Joint Spacing	12.5 feet each way for pavement thickness of 5 to 5.5 inches. 15 feet each way for pavement thickness of 6 inches or greater. Saw cut control joints should be cut within 6 to 12 hours of concrete placement.
Contraction Joint Depth	At least ¼ of pavement thickness.
Contraction Joint Width	One-fourth inch or as required by joint sealant manufacturer.
Construction Joint Spacing	To attempt to limit the quantity of joints in the pavement, consideration can be given to installing construction joints at contraction joint locations, where it is applicable.
Construction Joint Depth/Width	Full depth of pavement thickness. Construct sealant reservoir along one edge of the joint. Width of reservoir to be ¼ inch or as required by joint sealant manufacturer. Depth of reservoir to be at least ¼ of pavement thickness.
Isolation Joint Spacing	As required to isolate pavement from structures, etc.
Isolation Joint Depth	Full depth of pavement thickness.

Item	Description
Isolation Joint Width	½ to 1 inch or as required by the joint sealant manufacturer.
Expansion Joint	In this locale, drying shrinkage of concrete typically significantly exceeds anticipated expansion due to thermal affects. As a result, the need for expansion joints is eliminated provided all joints (including saw cuts) are sealed. Construction of an unnecessary joint may be also become a maintenance problem. All joints should be sealed. If all joints, including saw cuts, are not sealed then expansion joints should be installed.

All construction joints have dowels. Dowel information varies with pavement thickness as presented as follows:

Pavement Thickness, inches	5½ and 6 inches	7 and 7½ inches
Dowels Diameter, inches	¾ inch diameter	⅞ inch diameter
Dowel Spacing on Center, inches	12 inches on center	12 inches on center
Dowel Length, inches	14 inches long	14 inches long
Dowel Embedment, inches	6 inches	6 inches

1. In relatively thin pavement sections (7 inches or less) round dowels can be impractical or counterproductive. The use of dowels may be economically justified where there are poor subgrade support conditions or heavy truck traffic.

Pavement Drainage

Pavements should be sloped to provide rapid drainage of surface water. Water allowed to pond on or adjacent to the pavements could saturate the subgrade and contribute to premature pavement deterioration. In addition, the pavement subgrade should be graded to provide positive drainage within the granular base section. Appropriate sub-drainage or connection to a suitable daylight outlet should be provided to remove water from the granular subbase.

Long-term pavement performance will be dependent upon several factors, including maintaining subgrade moisture levels and providing for preventative maintenance. The following recommendations should be implemented to help promote long-term pavement performance:

- The subgrade and the pavement surface should be designed to promote proper surface drainage, preferably at a minimum grade of 2 percent;
- Install joint sealant and seal cracks immediately;

- Extend curbs into the subgrade for a depth of at least 6 inches or on top of limestone to help reduce moisture migration into the subgrade soils beneath the pavement section;
- Place compacted, low permeability clayey backfill against the exterior side of the curb and gutter.
- Slope subgrade in landscape islands to low points should drain to an appropriate outlet.

Pavement Maintenance

The pavement sections provided in this report represent minimum recommended thicknesses and, as such, periodic maintenance should be anticipated. Therefore preventive maintenance should be planned and provided for through an on-going pavement management program. Preventive maintenance activities are intended to slow the rate of pavement deterioration, and to preserve the pavement investment. Preventive maintenance consists of both localized maintenance (e.g. crack and joint sealing and patching) and global maintenance (e.g. surface sealing). Preventive maintenance is usually the first priority when implementing a planned pavement maintenance program and provides the highest return on investment for pavements. Prior to implementing any maintenance, additional engineering observation is recommended to determine the type and extent of preventive maintenance. Even with periodic maintenance, some movements and related cracking may still occur and repairs may be required.

Detention Pond

We understand that a detention pond is being considered for the proposed development. We anticipate that the detention pond may be constructed of earthen materials.

Generally, the base of the earthen ponds is critical when considering permeability and limiting detained waters from infiltrating through the detention pond's base. It is not uncommon for it to be acceptable for some water seepage to escape through the sidewalls of the berms of the pond. Typically, the design of the detention pond will attempt to limit the amount of detained water that may escape. A coefficient of permeability (k) of about 1×10^{-7} cm/sec or less would generally be suitable for the base of the pond. Polyvinyl Chloride (PVC) sheeting with a protective soil cover can also be considered for the pond's base. The top 2½ to 5 feet of existing soils at the site is primarily comprised of Fat Clay (CH) over Lean Clay (CL) and Marl. We do not recommend the use of the on-site Lean Clay (CL) soils or Marl to build the berm. Instead, a more cohesive material, such as layer I Fat Clay (CH), should be used for this purpose.

All clayey soil material to be used as fill for the berm construction should have a Plasticity Index (PI) of at least 30 percent and a Liquid Limit (LL) greater than 50 percent. This type of material may be suitable to construct the pond's base and berms provided it is

clean of organic material and gravel and is properly moisture conditioned and compacted. If the bottom and sides of any detention pond need to meet specific requirements for permeability, we will be happy to evaluate this further and provide recommendations to meet the necessary criteria.

In addition to permeability, the berms of the ponds should be stable. Generally, for clayey soils, the berms should be constructed with slopes not exceeding 3 horizontal to 1 vertical (3:1). Considerations should be given to vegetating the berms and base of the ponds to limit erosion. The clayey materials selected to construct the ponds should be placed in loose lifts not exceeding 8 inches and then be compacted lifts of about 6 inches in thickness. The materials should be moisture conditioned to between 0 to +4 percentage points of the optimum moisture content and compacted to at least 95 percent of ASTM D 698. Care should be taken to limit dry clods and provide a relatively homogenous mixture of clay material for the pond's base.

General Comments

Our analysis and opinions are based upon our understanding of the project, the geotechnical conditions in the area, and the data obtained from our site exploration. Variations will occur between exploration point locations or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. Terracon should be retained as the Geotechnical Engineer, where noted in this report, to provide observation and testing services during pertinent construction phases. If variations appear, we can provide further evaluation and supplemental recommendations. If variations are noted in the absence of our observation and testing services on-site, we should be immediately notified so that we can provide evaluation and supplemental recommendations.

This report should be provided in its entirety to the key members of the design team, namely the Architect, Civil Engineer, and Structural. In addition, the MEP engineer, the Landscape Architect, and others should be provided a copy as there may be geotechnical recommendations included herein related to their services.

Our Scope of Services does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

Our services and any correspondence are intended for the sole benefit and exclusive use of our client for specific application to the project discussed and are accomplished in accordance with generally accepted geotechnical engineering practices with no third-party beneficiaries intended. Any third-party access to services or correspondence is solely for information purposes to support the services provided by Terracon to our client. Reliance

upon the services and any work product is limited to our client and is not intended for third parties. Any use or reliance of the provided information by third parties is done solely at their own risk. No warranties, either express or implied, are intended or made.

Site characteristics as provided are for design purposes and not to estimate excavation cost. Any use of our report in that regard is done at the sole risk of the excavating cost estimator as there may be variations on the site that are not apparent in the data that could significantly impact excavation cost. Any parties charged with estimating excavation costs should seek their own site characterization for specific purposes to obtain the specific level of detail necessary for costing. Site safety and cost estimating including excavation support and dewatering requirements/design are the responsibility of others. Construction and site development have the potential to affect adjacent properties. Such impacts can include damages due to vibration, modification of groundwater/surface water flow during construction, foundation movement due to undermining or subsidence from excavation, as well as noise or air quality concerns. Evaluation of these items on nearby properties are commonly associated with contractor means and methods and are not addressed in this report. The owner and contractor should consider a preconstruction/precondition survey of surrounding development. If changes in the nature, design, or location of the project are planned, our conclusions and recommendations shall not be considered valid unless we review the changes and either verify or modify our conclusions in writing.

Figures

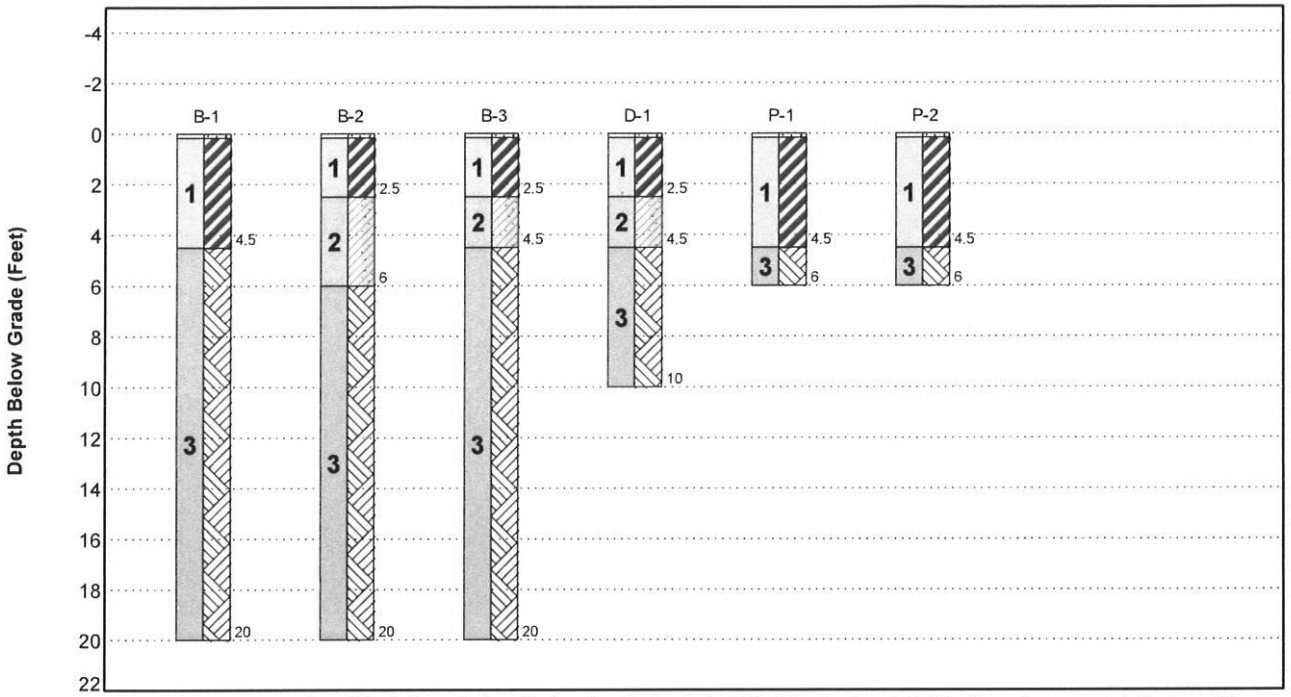
Contents:

GeoModel

Kendall County EMS Station No. 3
Voss Parkway | Boerne, TX
Terracon Project No. 90235101

Terracon
6911 Blanco Rd
San Antonio, TX

GeoModel



This is not a cross section. This is intended to display the Geotechnical Model only. See individual logs for more detailed conditions.

Model Layer	Layer Name	General Description
1	Fat Clay (CH)	With variable amounts of sand, medium stiff to very stiff, brown, tan
2	Lean Clay with Sand (CL)	Brown to tan, stiff to hard
3	Marl	Hard, tan

LEGEND

Topsoil
Fat Clay
Marl
Lean Clay with Sand

NOTES:
Layering shown on this figure has been developed by the geotechnical engineer for purposes of modeling the subsurface conditions as required for the subsequent geotechnical engineering for this project. Numbers adjacent to soil column indicate depth below ground surface.

Attachments

Exploration and Testing Procedures

Field Exploration

Number of Borings	Approximate Boring Depth (feet)	Location
3	20	Building
2	6	Pavement
1	10	Detention Pond

Boring Layout and Elevations: Terracon personnel provided the boring layout using handheld GPS equipment (estimated horizontal accuracy of about ±10 feet) and referencing existing site features. If elevations and a more precise boring layout are desired, we recommend borings be surveyed.

Subsurface Exploration Procedures: We advanced the borings with a truck-mounted, drill rig using continuous flight augers (solid stem). Five samples were obtained in the upper 10 feet of each boring and at intervals of 5 feet thereafter. In the thin-walled tube sampling procedure, a thin-walled, seamless steel tube with a sharp cutting edge was pushed hydraulically into the soil to obtain a relatively undisturbed sample. In the split-barrel sampling procedure, a standard 2-inch outer diameter split-barrel sampling spoon was driven into the ground by a 140-pound automatic hammer falling a distance of 30 inches. The number of blows required to advance the sampling spoon the last 12 inches of a normal 18-inch penetration is recorded as the Standard Penetration Test (SPT) resistance value. The SPT resistance values, also referred to as N-values, are indicated on the boring logs at the test depths. A 3-inch O.D. split-barrel sampling spoon with 2.5-inch I.D. ring lined sampler was used for soil sampling. For safety purposes, all borings were backfilled with auger cuttings after the groundwater observations were completed.

The sampling depths, penetration distances, and other sampling information was recorded on the field boring logs. The samples were placed in appropriate containers and taken to our soil laboratory for testing and classification by a Geotechnical Engineer. Our exploration team prepared field boring logs as part of the drilling operations. These field logs included visual classifications of the materials observed during drilling and our interpretation of the subsurface conditions between samples. Final boring logs were prepared from the field logs. The final boring logs represent the Geotechnical Engineer's interpretation of the field logs and include modifications based on observations and tests of the samples in our laboratory.

Laboratory Testing

The project engineer reviewed the field data and assigned laboratory tests. The laboratory testing program included the following types of tests:

- Moisture Content
- Grain Size Analysis
- Atterberg Limits
- Sulfate Tests

The laboratory testing program often included examination of soil samples by an engineer. Based on the results of our field and laboratory programs, we described and classified the soil samples in accordance with the Unified Soil Classification System.

Terracon

Site Location and Exploration Plans

Contents:

Site Location Plan
Exploration Plan

Note: All attachments are one page unless noted above.

Site Location

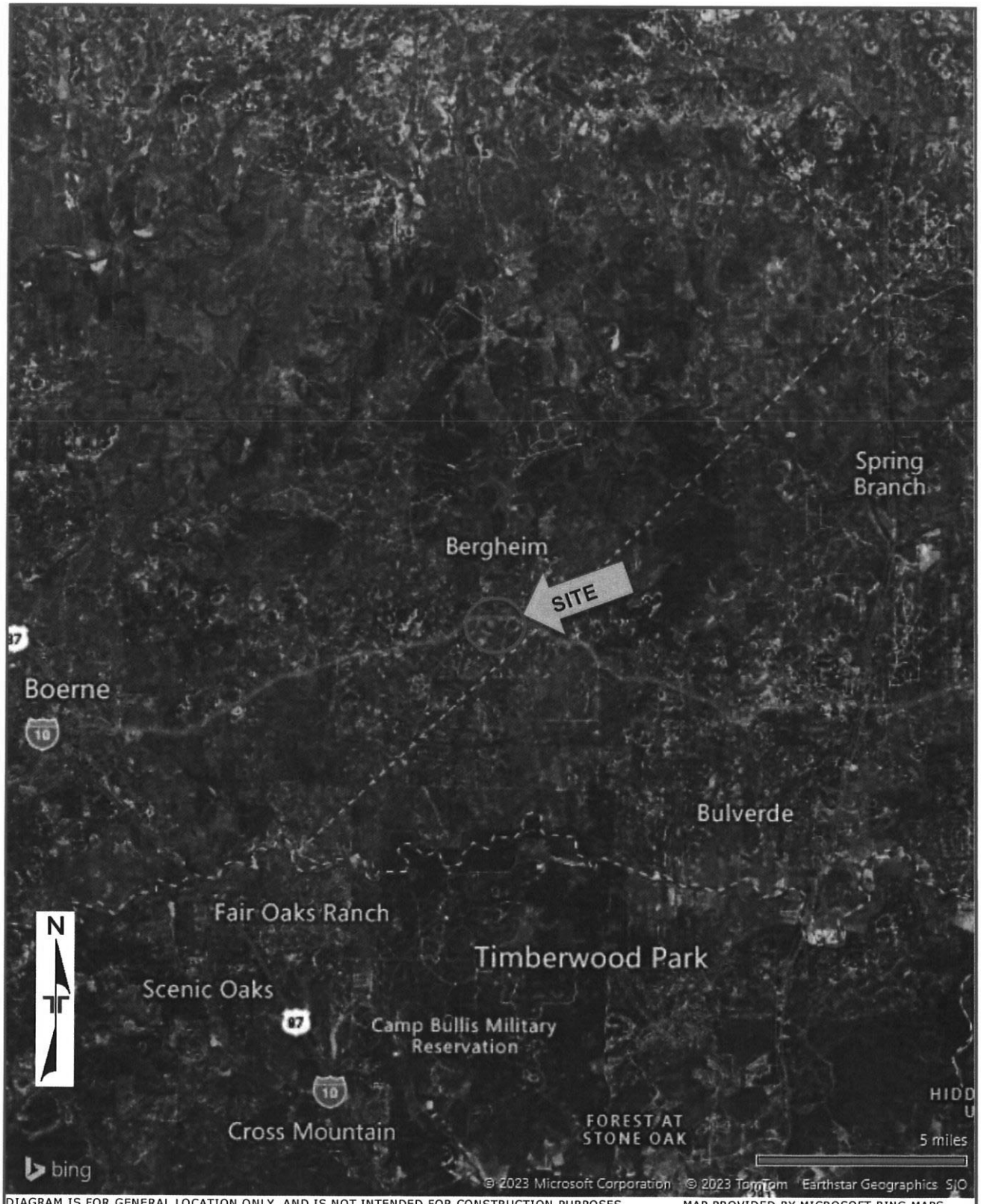


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

Exploration Plan

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

Exploration and Laboratory Results

Contents:

Boring Logs (B-1 through B-3, P-1 and P-2, D-1)
Atterberg Limits
Grain Size Distribution
Sulfate Test Results

Note: All attachments are one page unless noted above.

Kendall County EMS Station No. 3
Voss Parkway | Boerne, TX
Terracon Project No. 90235101

Terracon
6911 Blanco Rd
San Antonio, TX

Boring Log No. B-1

Location: See Exploration Plan

Latitude: 29.8248° Longitude: -98.5673°

Depth (Ft.) | Elevation: 1379 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Material Description	Elevation	Field Test Results	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
1		0.2	**TOPSOIL**	1378.83				
			FAT CLAY (CH), trace sand, brown, stiff		4-4-6 N=10	30.1	85-30-55	63
			- very stiff to hard below 2.5ft		5-8-23 N=31	23.7		
		4.5		1374.5				
3			**MARL**, tan, hard		50/2"	3.5	22-15-7	
					50/2"	6.9		
					37-50/1"	3.5		
					50/0"	6.6	28-14-14	
					14-19-23 N=42			
		20.0		1359				
			Boring Terminated at 20 Feet					

Depth (Ft.): 5, 10, 15, 20

Water Level Observations: No free water observed

Sample Type

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes

Elevation Reference: Elevations were interpolated from a topographic site plan.

Advancement Method
Flight Auger

Abandonment Method
Boring backfilled with auger cuttings upon completion.

Drill Rig
CME 75

Hammer Type
Automatic

Driller
Ramco/ Derrick

Logged by
Moe

Boring Started
04-17-2022

Boring Completed
04-17-2022

Kendall County EMS Station No. 3
Voss Parkway | Boerne, TX
Terracon Project No. 90235101

Terracon
6911 Blanco Rd
San Antonio, TX

Boring Log No. B-2

Location: See Exploration Plan
Latitude: 29.8250° Longitude: -98.5674°

Model Layer	Graphic Log	Depth (Ft.)	Elevation: 1380 (Ft.) +/-	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		0.2	**TOPSOIL** 1379.83							
1		2.5	**FAT CLAY (CH)**, trace sand, brown, stiff 1377.5				2-3-6 N=9	25.7		
2		6.0	**LEAN CLAY WITH SAND (CL)**, tan, hard 1374	5			15-16-16 N=32	12.1	29-19-10	
							8-18-36 N=54	10.9		55
3		20.0	**MARL**, tan, hard 1360	10			50/0"	9.8	31-16-15	
							50/0"	5.1		40
				15			50/0"	6.5		
							50/0"	5.6		
			Boring Terminated at 20 Feet	20						

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes
Elevation Reference: Elevations were interpolated from a topographic site plan.

Water Level Observations
No free water observed

Advancement Method
Flight Auger

Abandonment Method
Boring backfilled with auger cuttings upon completion.

Drill Rig
CME 75

Hammer Type
Automatic

Driller
Ramco/ Derrick

Logged by
Moe

Boring Started
04-17-2022

Boring Completed
04-17-2022

Kendall County EMS Station No. 3
Voss Parkway | Boerne, TX
Terracon Project No. 90235101

Terracon
6911 Blanco Rd
San Antonio, TX

Boring Log No. B-3

Location: See Exploration Plan

Latitude: 29.8251° Longitude: -98.5674°

Model Layer	Graphic Log	Depth (Ft.)	Elevation: 1379.5 (Ft.) +/-	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		0.2	**TOPSOIL** 1379.33							
1		2.5	**FAT CLAY (CH)**, trace sand, brown, medium stiff 1377				2-2-4 N=6	30.5	63-23-40	
2		4.5	**LEAN CLAY WITH SAND (CL)**, tan, very stiff 1375				7-10-15 N=25	21.4		72
3			**MARL**, tan, hard	5			25-30-35 N=65	6.6		
							50/0"	7.2		48
				10			50/0"	4.7	21-14-7	
							50/0"	6.9		
				15						
							50/0"	6.7		
		20.0	1359.5	20						
			Boring Terminated at 20 Feet							

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes

Elevation Reference: Elevations were interpolated from a topographic site plan.

Water Level Observations
No free water observed

Advancement Method
Flight Auger

Abandonment Method
Boring backfilled with auger cuttings upon completion.

Drill Rig
CME 75

Hammer Type
Automatic

Driller
Ramco/ Derrick

Logged by
Moe

Boring Started
04-17-2022

Boring Completed
04-17-2022

Kendall County EMS Station No. 3
Voss Parkway | Boerne, TX
Terracon Project No. 90235101

Terracon
6911 Blanco Rd
San Antonio, TX

Boring Log No. D-1

Location: See Exploration Plan

Latitude: 29.8244° Longitude: -98.5671°

Model Layer	Graphic Log	Depth (Ft.)	Elevation: 1377 (Ft.) +/-	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		0.2	**TOPSOIL** 1376.83							
1			**FAT CLAY (CH)**, trace sand, brown, stiff				4-5-8 N=13	34.7		68
		2.5	1374.5							
2			**LEAN CLAY WITH SAND (CL)**, tan, hard				8-14-23 N=37	3.8	25-20-5	
		4.5	1372.5							
3			**MARL**, tan, hard	5			14-16-28 N=44	8.3		50
							19-31-50/1"	4.6		
							50/2"	2.3		
		10.0	1367	10						
			Boring Terminated at 10 Feet							

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes

Elevation Reference: Elevations were interpolated from a topographic site plan.

Water Level Observations
No free water observed

Advancement Method
Flight Auger

Abandonment Method
Boring backfilled with auger cuttings upon completion.

Drill Rig
CME 75

Hammer Type
Automatic

Driller
Ramco/ Derrick

Logged by
Moe

Boring Started
04-17-2022

Boring Completed
04-17-2022

Kendall County EMS Station No. 3
Voss Parkway | Boerne, TX
Terracon Project No. 90235101

Terracon
6911 Blanco Rd
San Antonio, TX

Boring Log No. P-1

Location: See Exploration Plan

Latitude: 29.8249° Longitude: -98.5676°

Depth (Ft.) | Elevation: 1382 (Ft.) +/-

Model Layer	Graphic Log	Depth (Ft.)	Elevation	Material Description	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
1		0.2	1381.83	**TOPSOIL**							
				FAT CLAY (CH), trace sand, brown, stiff to very stiff				4-7-5 N=12	25.5	55-24-31	
								6-7-18 N=25	31.5		
		4.5	1377.5		5						
3				**MARL**, tan, hard				50/0"			
		6.0	1376								
				Boring Terminated at 6 Feet							

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes

Elevation Reference: Elevations were interpolated from a topographic site plan.

Water Level Observations
No free water observed

Advancement Method
Flight Auger

Abandonment Method
Boring backfilled with auger cuttings upon completion.

Drill Rig
CME 75

Hammer Type
Automatic

Driller
Ramco/ Derrick

Logged by
Moe

Boring Started
04-17-2022

Boring Completed
04-17-2022

Kendall County EMS Station No. 3
Voss Parkway | Boerne, TX
Terracon Project No. 90235101

Terracon
6911 Blanco Rd
San Antonio, TX

Boring Log No. P-2

Location: See Exploration Plan
Latitude: 29.8251° Longitude: -98.5672°

Model Layer	Graphic Log	Depth (Ft.)	Elevation: 1378 (Ft.) +/-	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
		0.2	**TOPSOIL** 1377.83							
1			**FAT CLAY (CH)**, trace sand, brown, stiff				5-4-5 N=9	21.9		
							4-4-6 N=10	29.1	78-26-52	
		4.5	1373.5							
3			**MARL**, tan, hard	5			23-50/4"	9.3		
		6.0	1372							
			Boring Terminated at 6 Feet							

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes

Elevation Reference: Elevations were interpolated from a topographic site plan.

Water Level Observations
No free water observed

Advancement Method
Flight Auger

Abandonment Method
Boring backfilled with auger cuttings upon completion.

Drill Rig
CME 75

Hammer Type
Automatic

Driller
Ramco/ Derrick

Logged by
Moe

Boring Started
04-17-2022

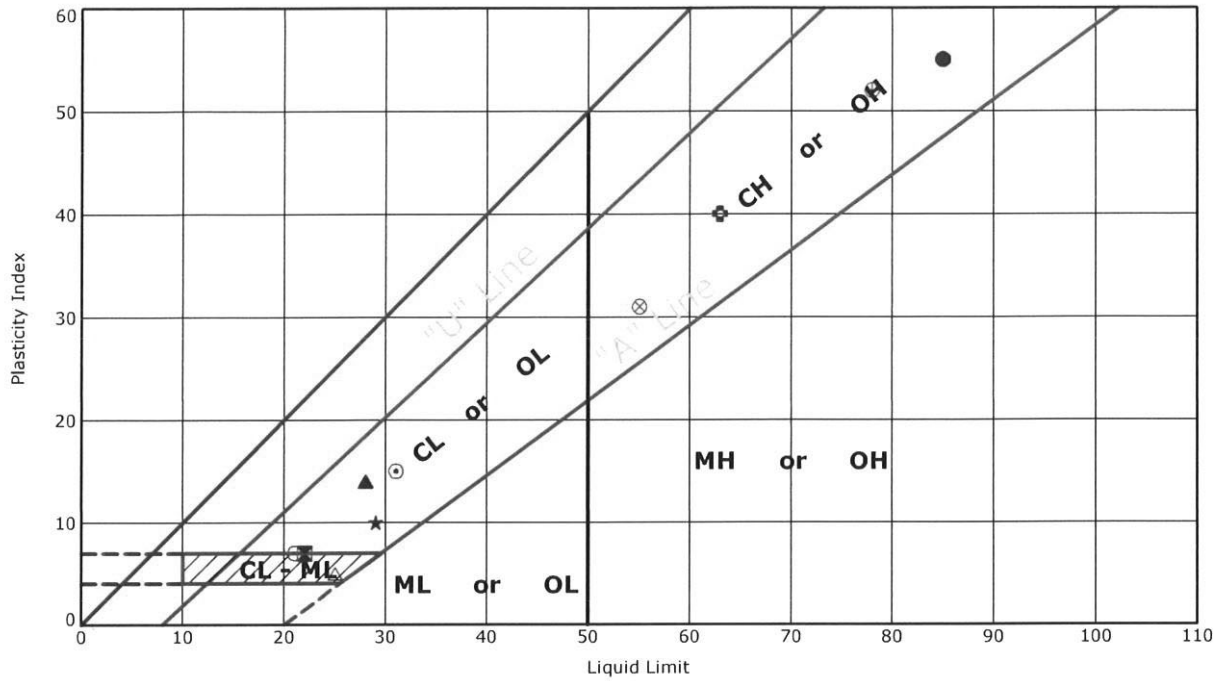
Boring Completed
04-17-2022

Kendall County EMS Station No. 3
Voss Parkway | Boerne, TX
Terracon Project No. 90235101

Terracon
6911 Blanco Rd
San Antonio, TX

Atterberg Limit Results

ASTM D4318



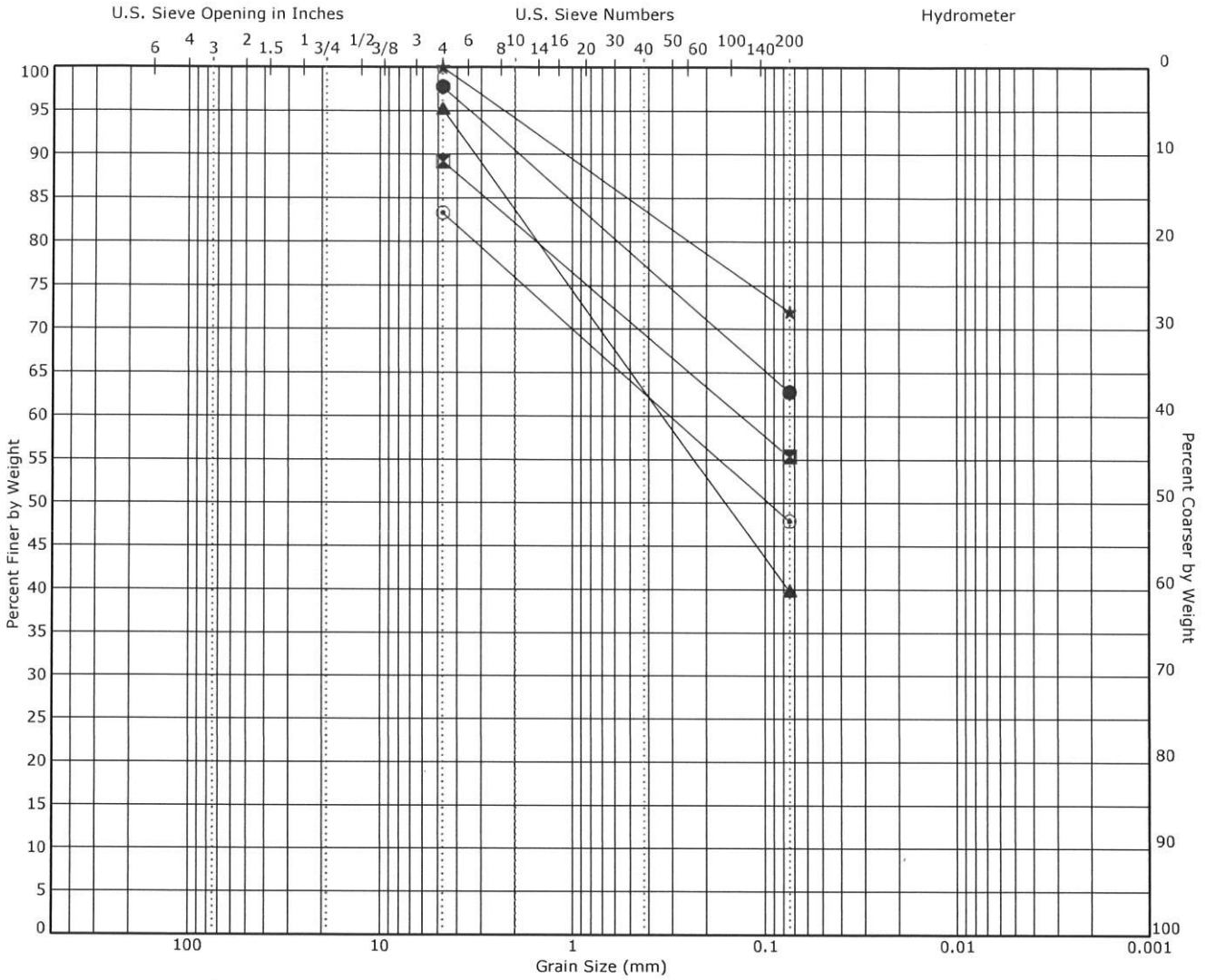
	Boring ID	Depth (Ft)	LL	PL	PI	Fines	USCS	Description
●	B-1	0	85	30	55	62.8	CH	SANDY FAT CLAY
▣	B-1	4.5	22	15	7			
▲	B-1	13.5	28	14	14			
★	B-2	2.5	29	19	10			
⊙	B-2	6.5	31	16	15			
✿	B-3	0	63	23	40			
○	B-3	8.5	21	14	7			
△	D-1	2.5	25	20	5			
⊗	P-1	0	55	24	31			
⊕	P-2	2.5	78	26	52			

Kendall County EMS Station No. 3
Voss Parkway | Boerne, TX
Terracon Project No. 90235101

Terracon
6911 Blanco Rd
San Antonio, TX

Grain Size Distribution

ASTM D422 / ASTM C136



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

Boring ID		Depth (Ft)	Description		LL	PL	PI	Cc	Cu
●	B-1	0	SANDY FAT CLAY		85	30	55		
⊠	B-2	4.5							
▲	B-2	8.5							
★	B-3	2.5							
⊙	B-3	6.5							

Boring ID		Depth (Ft)	D_{100}	D_{60}	D_{30}	D_{10}	%Cobbles	%Gravel	%Sand	%Fines	%Silt	%Clay
●	B-1	0	4.75						35.0	62.8		
⊠	B-2	4.5	4.75	0.133					33.9	55.4		
▲	B-2	8.5	4.75	0.339					55.4	39.9		
★	B-3	2.5	4.75				0.0	0.0	28.0	72.0		
⊙	B-3	6.5	4.75	0.309					35.4	47.9		

Kendall County EMS Station No. 3
Voss Parkway | Boerne, TX
Terracon Project No. 90235101

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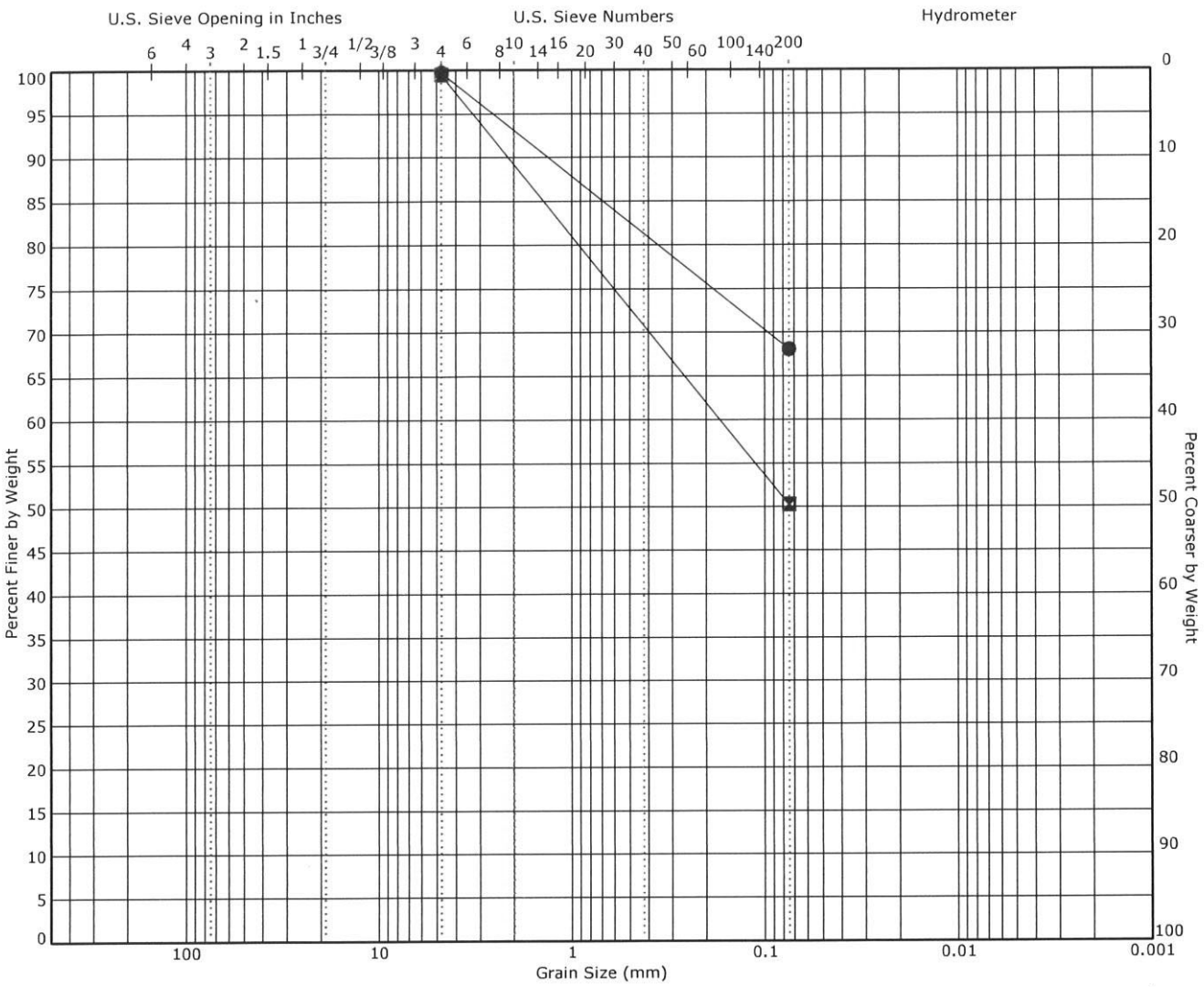
6911 Blanco Rd
San Antonio, TX

Grain Size Distribution

ASTM D422 / ASTM C136



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

Boring ID	Depth (Ft)	Description		LL	PL	PI	Cc	Cu
● D-1	0							
⊠ D-1	4.5							

Boring ID	Depth (Ft)	D_{100}	D_{60}	D_{30}	D_{10}	%Cobbles	%Gravel	%Sand	%Fines	%Silt	%Clay
● D-1	0	4.75						31.6	68.1		
⊠ D-1	4.5	4.75	0.17					49.2	50.3		

CLIENT: Terracon Consultants, Inc. **Project:** 90235101
Lab Order: 2304086

Alamo Lab ID	Client ID	Collection Date	Analyses	Matrix	Result	MDL	PQL	Units	DF	Qua
TestName: TEX-620-J			**TestNo:** TX620J	**Date Analyzed** 4/27/2023 8:30:00 AM				Initials: YK		
2304086-01A	B - 1 2.5 - 4	4/24/2023	Sulfate	Solid	136	0	25	mg/Kg	1	
2304086-02A	B - 3 4.5 - 6	4/24/2023	Sulfate	Solid	34	0	25	mg/Kg	1	
2304086-03A	P - 2 0 - 1.5	4/24/2023	Sulfate	Solid	70.6	0	25	mg/Kg	1	

H Holding times for preparation or analysis exceeded; J - Analyte detected below quanititation limits

* Non-NELAP Standards ** Sub Contracted

Approved by: Reddy Gosala, Laboratory Direc

Report of Laboratory Analysis

Supporting Information

Contents:

General Notes
Unified Soil Classification System

Note: All attachments are one page unless noted above.

Terracon
6911 Blanco Rd
San Antonio, TX

General Notes

Sampling	Water Level	Field Tests
Split Spoon	Water Initially Encountered Water Level After a Specified Period of Time Water Level After a Specified Period of Time Cave In Encountered Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.	N Standard Penetration Test Resistance (Blows/Ft.) (HP) Hand Penetrometer (T) Torvane (DCP) Dynamic Cone Penetrometer UC Unconfined Compressive Strength (PID) Photo-Ionization Detector (OVA) Organic Vapor Analyzer

Descriptive Soil Classification

Soil classification as noted on the soil boring logs is based Unified Soil Classification System. Where sufficient laboratory data exist to classify the soils consistent with ASTM D2487 "Classification of Soils for Engineering Purposes" this procedure is used. ASTM D2488 "Description and Identification of Soils (Visual-Manual Procedure)" is also used to classify the soils, particularly where insufficient laboratory data exist to classify the soils in accordance with ASTM D2487. In addition to USCS classification, coarse grained soils are classified on the basis of their in-place relative density, and fine-grained soils are classified on the basis of their consistency. See "Strength Terms" table below for details. The ASTM standards noted above are for reference to methodology in general. In some cases, variations to methods are applied as a result of local practice or professional judgment.

Location And Elevation Notes

Exploration point locations as shown on the Exploration Plan and as noted on the soil boring logs in the form of Latitude and Longitude are approximate. See Exploration and Testing Procedures in the report for the methods used to locate the exploration points for this project. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

Strength Terms

Relative Density of Coarse-Grained Soils
(More than 50% retained on No. 200 sieve.)
Density determined by Standard Penetration Resistance

Relative Density	Standard Penetration or N-Value (Blows/Ft.)
Very Loose	0 - 3
Loose	4 - 9
Medium Dense	10 - 29
Dense	30 - 50
Very Dense	> 50

Consistency of Fine-Grained Soils
(50% or more passing the No. 200 sieve.)
Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance

Consistency	Unconfined Compressive Strength Qu (tsf)	Standard Penetration or N-Value (Blows/Ft.)
Very Soft	less than 0.25	0 - 1
Soft	0.25 to 0.50	2 - 4
Medium Stiff	0.50 to 1.00	4 - 8
Stiff	1.00 to 2.00	8 - 15
Very Stiff	2.00 to 4.00	15 - 30
Hard	> 4.00	> 30

Relevance of Exploration and Laboratory Test Results

Exploration/field results and/or laboratory test data contained within this document are intended for application to the project as described in this document. Use of such exploration/field results and/or laboratory test data should not be used independently of this document.

Terracon

Unified Soil Classification System

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]				Soil Classification	
				Group Symbol	Group Name [B]
Coarse-Grained Soils: More than 50% retained on No. 200 sieve	**Gravels:** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels:** Less than 5% fines [C]	Cu≥4 and 1≤Cc≤3 [E]	GW	Well-graded gravel [F]
			Cu<4 and/or [Cc<1 or Cc>3.0] [E]	GP	Poorly graded gravel [F]
		Gravels with Fines: More than 12% fines [C]	Fines classify as ML or MH	GM	Silty gravel [F, G, H]
			Fines classify as CL or CH	GC	Clayey gravel [F, G, H]
	Sands: 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands:** Less than 5% fines [D]	Cu≥6 and 1≤Cc≤3 [E]	SW	Well-graded sand [I]
			Cu<6 and/or [Cc<1 or Cc>3.0] [E]	SP	Poorly graded sand [I]
		Sands with Fines: More than 12% fines [D]	Fines classify as ML or MH	SM	Silty sand [G, H, I]
			Fines classify as CL or CH	SC	Clayey sand [G, H, I]
Fine-Grained Soils: 50% or more passes the No. 200 sieve	**Silts and Clays:** Liquid limit less than 50	**Inorganic:**	PI > 7 and plots above "A" line [J]	CL	Lean clay [K, L, M]
			PI < 4 or plots below "A" line [J]	ML	Silt [K, L, M]
		Organic:	$\frac{LL\ oven\ dried}{LL\ not\ dried} < 0.75$	OL	Organic clay [K, L, M, N] / Organic silt [K, L, M, O]
	Silts and Clays: Liquid limit 50 or more	**Inorganic:**	PI plots on or above "A" line	CH	Fat clay [K, L, M]
			PI plots below "A" line	MH	Elastic silt [K, L, M]
		Organic:	$\frac{LL\ oven\ dried}{LL\ not\ dried} < 0.75$	OH	Organic clay [K, L, M, P] / Organic silt [K, L, M, Q]
Highly organic soils:	Primarily organic matter, dark in color, and organic odor			PT	Peat

[A] Based on the material passing the 3-inch (75-mm) sieve.
[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.
[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.
[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay.
[E] $Cu = D_{60}/D_{10}$ $Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$
[F] If soil contains ≥ 15% sand, add "with sand" to group name.
[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.
[H] If fines are organic, add "with organic fines" to group name.
[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.
[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.
[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.
[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.
[N] PI ≥ 4 and plots on or above "A" line.
[O] PI < 4 or plots below "A" line.
[P] PI plots on or above "A" line.
[Q] PI plots below "A" line.