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SECTION 00-0105.06
MECHANICAL CERTIFICATION

MECHANICAL ENGINEERING CERTIFICATION

MECHANICAL ENGINEER
Jeffrey E Kulhanek, P.E., The Schemmer Associates

I hereby certify that the applicable portions of these drawings and specifications were prepared by me or under my direct supervision and that I am a duly licensed Professional Engineer under the laws of the State of Missouri. I am responsible for the mechanical engineering for this project.

BY:_____ DATE: 2/3/26

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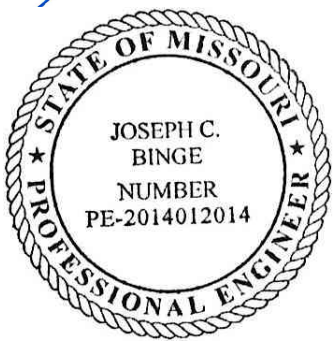
SECTION 00-0105.07
ELECTRICAL CERTIFICATION

ELECTRICAL ENGINEERING CERTIFICATION

ELECTRICAL ENGINEER
Joseph Binge, P.E., The Schemmer Associates

I hereby certify that the applicable portions of these drawings and specifications were prepared by me or under my direct supervision and that I am a duly licensed Professional Engineer under the laws of the State of Missouri. I am responsible for the electrical engineering for this project.

BY:_____ DATE: 02/03/2026



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SECTION 23-0519 - METERS AND GAUGES FOR HVAC PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Pressure gauges and pressure gauge taps.

B. Thermometers and thermometer wells.

1.02 SUBMITTALS

A. See Section 01-3000 - ADMINISTRATIVE REQUIREMENTS, for submittal procedures.

B. Product Data: Provide list that indicates use, operating range, total range and location for manufactured components.

1.03 FIELD CONDITIONS

A. Do not install instrumentation when areas are under construction, except for required rough-in, taps, supports and test plugs.

PART 2 PRODUCTS

2.01 PRESSURE GAUGES

A. Manufacturers:

1. Dwyer Instruments, Inc.
2. Omega Engineering, Inc.
3. Ashcroft Inc..
4. [Miljoco Corporation.]
5. [Tel-Tru Manufacturing Company.].
6. [Trerice, H. O. Co.].
7. [Watts Regulator Co.; a div of Watts Water Technologies, Inc.].
8. [Weiss Instruments, Inc].
9. [Winters Instruments - U.S.].
10. Substitutions: See Section 01-6000 - PRODUCT REQUIREMENTS.

B. Pressure Gauges: ASME B40.100, UL 393 Sealed cast alumnium or drawn steel case, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background.

1. Case: Steel or Cast Alumnium.
2. Window: Glass with stainless steel ring.
3. Size: 4-1/2 inch diameter.
4. Mid-Scale Accuracy: Plus or Minus One percent.
5. Scale: Psi and KPa.

2.02 PRESSURE GAUGE TAPPINGS

A. Gauge Cock: Tee or lever handle, brass or stainless steel for maximum 150 psi.

B. Needle Valve: Brass, 1/4 inch NPT for minimum 150 psi.

C. Pulsation Damper: Pressure snubber, brass with NPS 1/4 OR NPA 1/2 connections.

D. Syphon: Steel, Schedule 40, 1/4 inch angle or straight pattern.

2.03 STEM TYPE THERMOMETERS

A. Manufacturers:
   1. Dwyer Instruments, Inc.
   2. Trerice, H.O. Co.
   3. Weiss Instruments, Inc.
   4. Winters Instruments - U.S.
   5. Substitutions: See Section 01-6000 - PRODUCT REQUIREMENTS.

B. Thermometers - Light Activated Digital.
   1. Case: Plastic 5 inch or larger with adjustable angle neck.
   2. Stem: Alumnium. Designed for installation in thermowell.
   3. Accuracy: 2 percent, per ASTM E77.
   4. Calibration: Degrees F and Degrees C.

2.04 THERMOMETER SUPPORTS (THERMOWELLS)

A. Socket: Brass separable sockets for thermometer stems with or without extensions as required, and with cap and chain.
   1. Material:
      a. Copper Piping: Copper Nickel Alloy
      b. Steel Piping: Corrosion Resistant Steel
   2. Type: Stepped Shank unless straight or tapered shank is indicated.
   3. External Threads: NPS 1/2, NPS 3/4, or NPS 1 ASME B1.20.1 pipe threads.
   4. Internal Threads: 1/2, 3/4, or 1 inch ASME B1.1 screw threads.
   5. Bore: Diameter required to math thermometer stem.
   6. Insertion Length. Length required to match thermometer stem.

B. Heat Transfer Medium: Mixture or graphice and glycerin.

2.05 TEST PLUGS

A. Test Plug: 1/4 inch or 1/2 inch brass fitting and cap for receiving 1/8 inch outside diameter pressure or temperature probe with neoprene core for temperatures up to 200 degrees F.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install thermowells with socket extending to center of pipe and in vertical position in piping tees.

C. Install thermowells with extension in insulated piping.

D. Install pressure gauges in the following locations:
   1. Inlet and oulet of each chiller chilled water and condenser water connection.
   2. Suction and discharge of each pump.

E. Install pressure gauges with pulsation dampers. Provide gauge cock to isolate each gauge. Extend nipples and siphons to allow clearance from insulation.

F. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inch for installation of thermometer sockets. Ensure sockets allow clearance from insulation.

G. Install thermometer sockets adjacent to controls system thermostat, transmitter, or sensor sockets and in the following locations:
   1. Inlet and outlet of each hydronic zone.
   2. Inlet and outlet of each hydronic boiler or heat exchanger.
   3. Inlet and oulet of all piping at chillers.
   4. Inlet and oulet of each hydronic coil in an air handling unit.
   5. Inlet and oulet of each thermal storage tank.

H. Provide instruments with scale ranges selected according to service with largest appropriate scale.

I. Install gauges and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.

J. Locate test plugs adjacent to control device sockets.

END OF SECTION 23-0519

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SECTION 23-0523 - GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Ball valves.
B. Butterfly valves.
C. Check valves.

1.02 SUBMITTALS

A. See Section 01-3000 - Administrative Requirements for submittal procedures.
B. Product Data: Provide data on valves including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.
C. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts listings.

1.03 QUALITY ASSURANCE

1.04 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
   1. Minimize exposure of operable surfaces by setting plug and ball valves to open position.
   2. Protect valve parts exposed to piped medium against rust and corrosion.
   3. Protect valve piping connections such as grooves, weld ends, threads, and flange faces.
   4. Adjust globe, gate, and angle valves to the closed position to avoid clattering.
   5. Secure check valves in either the closed position or open position.
   6. Adjust butterfly valves to closed or partially closed position.
B. Use the following precautions during storage:
   1. Maintain valve end protection and protect flanges and specialties from dirt.
      a. Provide temporary inlet and outlet caps.
      b. Maintain caps in place until installation.
   2. Store valves in shipping containers and maintain in place until installation.
      a. Store valves indoors in dry environment.
      b. Store valves off the ground in watertight enclosures when indoor storage is not an option.
C. Exercise the following precautions for handling:
   1. Handle large valves with sling, modified to avoid damage to exposed parts.
   2. Avoid the use of operating handles or stems as rigging or lifting points.

PART 2 PRODUCTS

2.01 APPLICATIONS

A. Listed pipe sizes shown using nominal pipe sizes (NPS) and nominal diameter (DN).
B. Provide the following valves for the applications if not indicated on drawings:
   1. Throttling (Hydronic): Butterfly and Ball.
   2. Throttling (Steam): Globe.

3. Isolation (Shutoff): Butterfly and Ball.
4. Swing Check (Pump Outlet):
   a. Size 2 inch and Smaller: Bronze with bronze disc.
   b. Size 2-1/2 inch and Larger: Iron with lever and weight, lever and spring, center-guided metal, or center-guided with resilient seat.
5. Dead-End: Butterfly, single-flange (lug) type.

C. Required Valve End Connections for Non-Wafer Types:
1. Steel Pipe:
   a. Size 2 inch and Smaller: Threaded ends.
   b. Size 2-1/2 inch and Larger: Grooved or Flanged Ends
2. Copper Tube:
   a. Size 2 inch and Smaller: Threaded ends, except solder-joint valve-ends.
   b. Size 2-1/2 inch and Larger: Grooved ends.

D. Condenser Water Valves:
1. Size 2 inch and Smaller, Bronze Valves:
   a. _____ solder joint ends.
   b. Ball: Full port, two piece, bronze trim.
   c. Swing Check: Bronze disc, Class 125.
2. Size 2-1/2 inch and Larger, Iron Valves:
   a. 2-1/2 inch to 4 inch: Flanged ends.
   b. Single-Flange Butterfly: 2-1/2 inch to 12 inch, aluminum-bronze disc, EPDM seat, 200 CWP.
   c. Single-Flange Butterfly: 14 inch to 24 inch, 150 CWP, aluminum-bronze disc, EPDM seat, 150 CWP.
   d. Grooved-End Butterfly: 2-1/2 inch to 12 inch, 175 CWP.
   e. Swing Check: Metal seats, Class 125.
   f. Grooved-End Swing Check: 3 inch to 12 inch, 300 CWP.
   g. Iron Center-Guided Check: 2-1/2 inch to 24 inch, compact-wafer, metal seat, Class 125.

E. Heating Hot Water Valves:
1. Size 2 inch and Smaller, Bronze Valves:
   a. Flanged or solder-joint ends
   b. Ball: Full port, two piece, brass trim.
   c. Swing Check: Bronze disc, Class 125.
2. Size 2-1/2 inch and Larger, Iron Valves:
   a. 2-1/2 inch to 4 inch: Threaded ends.
   b. Single-Flange Butterfly: 2-1/2 inch to 12 inch, aluminum-bronze disc, EPDM seat, 200 CWP.

c. Single-Flange Butterfly: 14 inch to 24 inch, aluminum-bronze disc, EPDM seat, 150 CWP.
d. Grooved-End Butterfly: 2-1/2 inch to 12 inch, 175 CWP.
e. Swing Check: Metal seats, Class 125.
f. Grooved-End Swing Check: 3 inch to 12 inch, 300 CWP.
g. Center-Guided Check: Compact-wafer, metal seat, Class 125.

2.02 GENERAL REQUIREMENTS

A. Valve Pressure and Temperature Ratings: No less than rating indicated; as required for system pressures and temperatures.
B. Valve Sizes: Match upstream piping unless otherwise indicated.
C. Valve Actuator Types:
1. Handwheel: Valves other than quarter-turn types.
2. Hand Lever: Quarter-turn valves 6 inch and smaller.
3. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator, of size and with chain for mounting height, as indicated in the "Valve Installation" Article.
D. Valves in Insulated Piping: Provide 2 inch stem extensions and the following features:
1. Gate Valves: Rising stem.
2. Ball Valves: Extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
3. Butterfly Valves: Extended neck.
E. Valve-End Connections:
1. Threaded End Valves: ASME B1.20.1.
2. Flanges on Iron Valves: ASME B16.1 for flanges on iron valves.
3. Solder Joint Connections: ASME B16.18.
4. Grooved End Connections: AWWA C606.
F. General ASME Compliance:
1. Ferrous Valve Dimensions and Design Criteria: ASME B16.10 and ASME B16.34.
2. Building Services Piping Valves: ASME B31.9.
G. Bronze Valves:
1. Fabricate from dezincification resistant material.
2. Copper alloys containing more than 15 percent zinc are not permitted.
H. Source Limitations: Obtain each valve type from a single manufacturer.

2.03 BRONZE, BALL VALVES

A. General:
1. Fabricate from dezincification resistant material.
2. Copper alloys containing more than 15 percent zinc are not permitted.
B. Two Piece, Full Port with Bronze Trim:
1. Comply with MSS SP-110.

2. WSP Rating: 150 psi.
3. CWP Rating: 600 psi.
4. Body: Forged bronze.
5. End Connections: Pipe thread or solder.
6. Seats: PTFE or TFE.
7. Stem: Bronze.
8. Ball: Chrome plated brass.
9. Operator: Provide lockable handle and stem extension.
10. Manufacturers:
    a. Apollo Valves; _____: www.apollovalves.com/#sle.
    b. FNW; X450: www.fnw.com/#sle.
    c. Conbraco Industries, Inc..
    d. [Crane Co.; Cranve Valve Group; Crane Valves.].
    e. [Hammond Valve.].
    f. [Lance Valves; a division of Advanced Thermal Systems, Inc.].
    g. [Milwaukee Valve Company.].
    h. [NIBCO INC.].
    i. [Red-White Valve Corporation.].
    j. [Watts Regulator Co.; a division of Watts Water Technologies, Inc.].

2.04 IRON, SINGLE FLANGE BUTTERFLY VALVES

A. Wafer Style:
1. Comply with MSS SP-67, Type I.
2. Lug Style, CWP Ratings:
    a. Sizes 2 to 12 inch: 150 psi.
    b. Vacuum Service: Down to 29.9 in-Hg.
3. Body Material: ASTM A126 cast iron or ASTM A536 ductile iron.
4. Stem: One or two-piece stainless steel.
5. Seat: EPDM.
6. Disc: Aluminum-bronze.
7. Manufacturers:
    a. Apollo Valves; _____: www.apollovalves.com/#sle.
    b. FNW; 711: www.fnw.com/#sle.
    c. Kitz Corporation of America; _____: www.kitzus-kca.com/#sle.
    d. Nexus Valve, Inc; _____: www.nexusvalve.com/#sle.
    e. Cooper Cameron Valves; a division of Cooper Cameron Corp..
    f. [Crane Co.; Crane Valve Group; Jenkins Valves.].
    g. [Crane Co.; Crane Valve Group; Stockham Division.].
    h. [Dezurik Water Controls.].

i. [Hammond Valve.].
j. [Kitz Corporation.].
k. [Milwaukee Valve Corporation.].
l. [NIBCO INC.].
m. [Norriseal; a Dover Corporation company.]
n. [Red-White Valve Corporation.].
o. [Spence Strainers International; a division of CIRCOR International.].
p. [Tyco Valves & Conrols; a unit of Tyco Flow Control.].
q. [Watts Regulator Co.; a division of Watts Water Technologies, Inc.].

2.05 IRON, GROOVED-END BUTTERFLY VALVES

A. CWP Rating: 175 psi.
1. Comply with MSS SP-67, Type I.
2. Body: Coated ductile iron.
3. Stem: Two-piece stainless steel.
4. Disc: Coated ductile iron.
5. Disc Seal: EPDM.
6. Manufacturers:
a. Kitz Corporation of America: www.kitzus-kca.com/#sle.
b. Tyco FireProducts
c. Victaulic
d. Shurjoint
e. Kennedy

2.06 BRONZE, SWING CHECK VALVES

A. Class 125:
1. Pressure and Temperature Rating: MSS SP-80, Type 3.
2. Design: Y-pattern, horizontal or vertical flow.
3. WSP Rating: 200 psi.
4. Body: Bronze, ASTM B62.
5. End Connections: Threaded or soldered.
6. Disc: Bronze.
7. Manufacturers:
a. Apollo Valves: www.apollovalves.com/#sle.
b. Kitz Corporation of America; #22: www.kitzus-kca.com/#sle.
c. Crane Co.; Crane Valve Group; Crane 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.].

2.07 IRON, FLANGED END SWING CHECK VALVES

A. Class 125:
1. 150 psi with metal seats.
2. 200 psi with metal seats and nonmetallic-to-metal seats.

B. Manufacturers:
1. Apollo Valves: www.apollovalves.com/#sle.
2. FNW; 671B: www.fnw.com/#sle.
3. Crane Co.; Crane Valve Group; Crane Valves..
4. [Crane Co.; Crane Valve Group; Jenkins Valves.].
5. [Crane Co.; Crane Valve Group; Stockham Division.].
6. [Hammond Valve.].
7. [Milwaukee Valve Company.].
8. [NIBCO INC.].
9. [Watts Regulator Co.; a division of Watts Water Technologies, Inc.].

2.08 IRON, GROOVED-END SWING CHECK VALVES

A. Class 300:
1. CWP Rating: 300 psi.
2. Body Material: ASTM A536, Grade 65-45-12 ductile iron.
3. Seal: EPDM or Nitrile.
4. Disc: Ductile iron.
5. Coating: Black, non-lead paint.
6. Manufacturers:
a. Shurjoint.
b. Tyco.
c. Victaulic
d.

2.09 IRON, CENTER-GUIDED CHECK VALVES

A. Class 125, Compact-Wafer:
1. Comply with MSS SP-125.
2. Sizes 2-1/2 to 12 inch: CWP Rating; 200 psi.
3. Body Material: ASTM A126, gray iron.
4. Metal Seat: Bronze.
5. Resilient Seat: EPDM or NBR.

PART 3 EXECUTION

3.01 EXAMINATION

A. Discard all packing materials and verify that valve interior, including threads and flanges, are completely clean without signs of damage or degradation that could result in leakage.

B. Verify valve parts to be fully operational in all positions from closed to fully open.

C. Confirm gasket material to be suitable for the service, to be of correct size, and without defects that could compromise effectiveness.

D. Should valve determined to be defective, replace with new valve.

3.02 INSTALLATION

A. Provide unions or flanges with valves to facilitate equipment removal and maintenance while maintaining system operation and full accessibility for servicing.

B. Provide separate valve support as required and locate valve with stem at or above center of piping, maintaining unimpeded stem movement.

C. Provide support of piping adjacent to valves such that no force is imposed on valves.

D. Install valves so that stems are horizontal or slope upward from centerline of pipe.

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

F. Install check valves where necessary to maintain direction of flow as follows:

1. Swing Check: Install horizontal maintaining hinge pin level.
2. Orient plate-type and center-guided into horizontal or vertical position, between flanges.

G. Provide chainwheels on operators for valves 4 NPS and larger where located 96 inches or more above finished floor, terminating 60 inches above finished floor.

END OF SECTION 23-0523

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SECTION 23-0529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Support and attachment components.

1.02 REFERENCE STANDARDS

A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

C. ASTM A181/A181M - Standard Specification for Carbon Steel Forgings, for General-Purpose Piping.

D. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.

E. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings.

F. ASTM A283/A283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.

G. ASTM A395/A395M - Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.

H. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

I. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.

J. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.

K. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

L. FM (AG) - FM Approval Guide.

M. MFMA-4 - Metal Framing Standards Publication.

N. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.

O. UL (DIR) - Online Certifications Directory.

P. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
2. Coordinate the work with other trades to provide additional framing and materials required for installation.
3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.

4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:
1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section 03-3000.

1.04 SUBMITTALS

A. See Section 01-3000 - ADMINISTRATIVE REQUIREMENTS for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for channel (strut) framing systems, nonpenetrating rooftop supports, post-installed concrete and masonry anchors, and thermal insulated pipe supports.

1.05 QUALITY ASSURANCE

A. Comply with applicable building code.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 SUPPORT AND ATTACHMENT COMPONENTS

A. General Requirements:
1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of plumbing work.
2. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
3. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported. Include consideration for vibration, equipment operation, and shock loads where applicable.
4. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
5. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
a. Indoor Dry Locations: Use zinc-plated steel or approved equivalent unless otherwise indicated.
b. Outdoor and Damp or Wet Indoor Locations: Use stainless steel or approved equivalent unless otherwise indicated.
c. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
d. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.

B. Prefabricated Trapeze-Framed Metal Strut Systems:

1. Manufacturers:
    a. ABB Installation Products: electrification.us.abb.com/#sle.
    b. B-Line, a brand of Eaton Corporation: www.eaton.com/#sle.
    c. Unistrut, a brand of Atkore International Inc: www.unistrut.com/#sle.
    d. Allied Tube & Conduit..
    e. [Flex-Strut Inc.].
    f. [Wesanco, Inc.].
    g. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
2. MFMA-4 compliant, pre-fabricated, MSS SP-58 type 59 continuous-slot metal strut channel with associated tracks, fittings, and related accessories.
3. Strut Channel or Bracket Material:
4. Minimum Channel Thickness: Steel sheet, 12 gauge, 0.1046 inch.
5. Minimum Channel Dimensions: 1-5/8 inch width by 13/16 inch height.
6. Accessories: Provide bracket covers, cable basket clips, cable tray clips, clamps, conduit clamps, fire-retarding brackets, j-hooks, protectors, and vibration dampeners.
7. Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
    a. 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.

C. Hanger Rods:
1. Threaded zinc-plated steel unless otherwise indicated.
2. Trim excess length of continuous thread hanger and support rods to 1-1/2 inches.

D. Thermal Insulated Pipe Supports:
1. General Requirements:
    a. Insulated pipe supports to be provided at hanger, support, and guide locations on pipe requiring insulation or additional support.
    b. Surface Burning Characteristics: Flame spread index/smoke developed index of 5/30, maximum, when tested in accordance with ASTM E84 or UL 723.
    c. Pipe supports to be provided for nominally sized, 1/2 to 30 inch iron pipes.
    d. Insulation inserts to consist of rigid polyisocyanurate (urethane) insulation surrounded by a 360 degree, PVC jacketing.
2. Pipe insulation protection shields to be provided at the hanger points and guide locations on pipes requiring insulation as indicated on drawings.

E. Pipe Supports:
1. Material: ASTM A395/A395M ductile iron, ASTM A36/A36M carbon steel, ASTM A47/A47M malleable iron, ASTM A181/A181M forged steel, or ASTM A283/A283M steel.
2. Liquid Temperatures Up To 122 degrees F:

a. Overhead Support: MSS SP-58 Types 1, 3 through 12.
b. Support From Below: MSS SP-58 Types 35 through 38.

3. Operating Temperatures from 122 to 446 degrees F:
   a. Overhead Support: MSS SP-58 Type 1 or 3 through 12, with appropriate saddle of MSS SP-58 Type 40 for insulated pipe.
   b. Roller Support: MSS SP-58 Types 41 or 43 through 46, with appropriate saddle of MSS SP-58 Type 39 for insulated pipe.

F. Beam Clamps:
1. MSS SP-58 types 19 through 23, 25 or 27 through 30 based on required load.
2. Beam C-Clamp: MSS SP-58 type 23, malleable iron and steel with plain, stainless steel, and zinc finish.
3. Small or Junior Beam Clamp: MSS SP-58 type 19, malleable iron with plain finish. For inverted usage provide manufacturer listed size(s).
4. Wide Mouth Beam Clamp: MSS SP-58 type 19, malleable iron with plain finish.
5. Centerload Beam Clamp with Extension Piece: MSS SP-58 type 30, malleable iron with plain finish.
6. FM (AG) and UL (DIR) Approved Beam Clamp: MSS SP-58 type 19, plain finish,
7. Provide clamps with hardened steel cup-point set screws and lock-nuts for anchoring in place.
8. Material: ASTM A395/A395M ductile iron, ASTM A36/A36M carbon steel, ASTM A47/A47M malleable iron, ASTM A181/A181M forged steel, or ASTM A283/A283M steel.

G. Riser Clamps:
1. For insulated pipe runs, provide two bolt-type clamps designed for installation under insulation.
2. MSS SP-58 type 1 or 8, carbon steel or steel with stainless steel or zinc plated finish.
3. Medium Split Horizontal Pipe Clamp: MSS SP-58 type 4, carbon steel or stainless steel with stainless steel or zinc plated finish.
4. Copper Tube Pipe Clamp: MSS SP-58 type 8, epoxy plated copper.
5. UL (DIR) listed: Pipe sizes 1/2 to 8 inch.

H. Pipe Hangers:
1. Band Hangers, Adjustable:
   a. MSS SP-58 Type 7 or 9, Zinc-plated ASTM A1011/A1011M steel or ASTM A653/A653M carbon steel.
2. Swivel Ring Hangers, Adjustable:
   a. MSS SP-58 Type 10, epoxy-painted, zinc-colored.
   b. Material: ASTM A395/A395M ductile iron, ASTM A36/A36M carbon steel, ASTM A47/A47M malleable iron, ASTM A181/A181M forged steel, or ASTM A283/A283M steel.
   c. FM (AG) and UL (DIR) listed for specific pipe size runs and loads.

3. Clevis Hangers, Adjustable:
    a. Copper Tube: MSS SP-58 Type 1, epoxy-plated copper.
    b. Standard-Duty: MSS SP-58 Type 1, zinc-colored, epoxy plated.

I. Dielectric Barriers: Provide between metallic supports and metallic piping and associated items of dissimilar type; acceptable dielectric barriers include rubber or plastic sheets or coatings attached securely to pipe or item.

J. Pipe Shields for Insulated Piping:
1. General Construction and Requirements:
    a. Surface Burning Characteristics: Comply with ASTM E84 or UL 723.
    b. Shields Material: _____.
    c. Maximum Insulated Pipe Outer Diameter: 12-5/8 inch.
    d. Minimum Service Temperature: Minus 40 degrees F.
    e. Maximum Service Temperature: 178 degrees F.
    f. Pipe shields to be provided at hanger, support, and guide locations on pipe requiring insulation or additional support.

K. Anchors and Fasteners:
1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
2. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
3. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
4. Hollow Masonry: Use toggle bolts.
5. Hollow Stud Walls: Use toggle bolts.
6. Steel: Use beam-ceiling clamps, beam clamps, machine bolts, or welded threaded studs.
7. Beam Ceiling Flanges: ASTM A47/A47M Grade 32510, malleable iron or stainless steel with copper, plain, stainless steel, or zinc finish.
8. Sheet Metal: Use sheet metal screws.
9. Wood: Use wood screws.
10. Plastic and lead anchors are not permitted.
11. Powder-actuated fasteners are not permitted.
12. Hammer-driven anchors and fasteners are not permitted.
13. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
    a. Comply with MFMA-4.
    b. Channel Material: Use galvanized steel.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that mounting surfaces are ready to receive support and attachment components.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

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

C. Provide independent support from building structure. Do not provide support from piping, ductwork, conduit, or other systems.

D. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.

E. Unless specifically indicated or approved by Architect, do not provide support from roof deck.

F. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.

G. Provide thermal insulated pipe supports complete with hangers and accessories. Install thermal insulated pipe supports during the installation of the piping system.

H. Equipment Support and Attachment:

1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
4. Unless otherwise indicated, mount floor-mounted equipment on properly sized 3-1/2 inch high concrete pad constructed in accordance with Section 03-3000.
5. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.

I. Preset Concrete Inserts: Use manufacturer-provided closure strips to inhibit concrete seepage during concrete pour.

J. Secure fasteners according to manufacturer's recommended torque settings.

K. Remove temporary supports.

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

3.03 FIELD QUALITY CONTROL

A. See Section 01-4000 - QUALITY REQUIREMENTS for additional requirements.

B. Inspect support and attachment components for damage and defects.

C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

D. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION 23-0529

SECTION 23-0553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Nameplates.
B. Tags.
C. Stencils.
D. Pipe markers.
E. Ceiling tacks.

1.02 SUBMITTALS

A. See Section 01-3000 - ADMINISTRATIVE REQUIREMENTS for submittal procedures.
B. Product Data: Provide manufacturers catalog literature for each product required.

PART 2 PRODUCTS

2.01 IDENTIFICATION APPLICATIONS

A. Air Handling Units: Nameplates.
B. Air Terminal Units: Tags.
C. Automatic Controls: Tags. Key to control schematic.
D. Control Panels: Nameplates.
E. Dampers: Ceiling tacks, where located above lay-in ceiling.
F. Ductwork: Stencilled painting.
G. Heat Transfer Equipment: Nameplates.
H. Instrumentation: Tags.
I. Major Control Components: Nameplates.
J. Piping: Pipe markers.
K. Pumps: Nameplates.
L. Small-sized Equipment: Tags.
M. Tanks: Nameplates.
N. Thermostats: Nameplates.
O. Valves: Tags and ceiling tacks where located above lay-in ceiling.

2.02 NAMEPLATES

A. Manufacturers:
   1. Advanced Graphic Engraving, LLC: www.advancedgraphicengraving.com/#sle.
   2. Brimar Industries, Inc: www.pipemarker.com/#sle.
   3. Craftmark Pipe Markers: www.craftmarkid.com/#sle.
   4. Kolbi Pipe Marker Co: www.kolbipipemarkers.com/#sle.
   5. Seton Identification Products, a Tricor Direct Company: www.seton.com/#sle.
B. Letter Color: White.
C. Letter Height: 1/4 inch.

D. Background Color: Black.

E. Plastic: Comply with ASTM D709.

2.03 TAGS

A. Manufacturers:

1. Advanced Graphic Engraving: www.advancedgraphicengraving.com/#sle.
2. Brady Corporation: www.bradycorp.com/#sle.
3. Brimar Industries, Inc: www.pipemarker.com/#sle.
4. Craftmark Pipe Markers: www.craftmarkid.com/#sle.
5. Kolbi Pipe Marker Co: www.kolbipipemarkers.com/#sle.
6. Seton Identification Products, a Tricor Company: www.seton.com/#sle.

B. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch diameter.

2.04 STENCILS

A. Manufacturers:

1. Brady Corporation: www.bradycorp.com/#sle.
2. Craftmark Pipe Markers: www.craftmarkid.com/#sle.
3. Insite Solutions, LLC: www.stop-painting.com/#sle.
4. Kolbi Pipe Marker Co: www.kolbipipemarkers.com/#sle.
5. Seton Identification Products, a Tricor Company: www.seton.com/#sle.

B. Stencils: With clean cut symbols and letters of following size:

1. Ductwork and Equipment: 2-1/2 inch high letters.

C. Stencil Paint: As specified in Section 09-9123, semi-gloss enamel, colors complying with ASME A13.1.

2.05 PIPE MARKERS

A. Color: Comply with ASME A13.1.

B. Plastic Pipe Markers: Factory fabricated, flexible, semi- rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.

C. Underground Plastic Pipe Markers: Bright-colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil, 0.004 inch thick, manufactured for direct burial service.

2.06 CEILING TACKS

A. Description: Steel with 3/4 inch diameter color coded head.

B. Color code as follows:

1. HVAC Equipment: Yellow.
2. Fire Dampers and Smoke Dampers: Red.
3. Heating/Cooling Valves: Blue.

PART 3 EXECUTION

3.01 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

3.02 INSTALLATION

A. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.

B. Install tags with corrosion resistant chain.

C. Apply stencil painting in accordance with Section 09-9123.

D. Install plastic pipe markers in accordance with manufacturer's instructions.

E. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.

F. Use tags on piping 3/4 inch diameter and smaller.

1. Identify service, flow direction, and pressure.
2. Install in clear view and align with axis of piping.
3. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction.

G. Locate ceiling tacks to locate valves or dampers above lay-in panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION 23-0553

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SECTION 23-0593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Testing, adjustment, and balancing of air systems.

1.02 SUBMITTALS

A. See Section 01-3000 - ADMINISTRATIVE REQUIREMENTS, for submittal procedures.

B. TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.

1. Submit to Architect.
2. Submit six weeks prior to starting the testing, adjusting, and balancing work.
3. Include at least the following in the plan:
   a. List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.
   b. Copy of field checkout sheets and logs to be used, listing each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.
   c. Identification and types of measurement instruments to be used and their most recent calibration date.
   d. Discussion of what notations and markings will be made on the duct and piping drawings during the process.
   e. Final test report forms to be used.
   f. Details of how TOTAL flow will be determined; for example:
      1) Air: Sum of terminal flows via control system calibrated readings or via hood readings of all terminals, supply (SA) and return air (RA) pitot traverse, SA or RA flow stations.
      2) Water: Pump curves, circuit setter, flow station, ultrasonic, etc.
   g. Specific procedures that will ensure that both air and water side are operating at the lowest possible pressures and methods to verify this.
   h. Procedures for formal deficiency reports, including scope, frequency and distribution.

C. Final Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.

1. Revise TAB plan to reflect actual procedures and submit as part of final report.
2. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect and for inclusion in operating and maintenance manuals.
3. Include actual instrument list, with manufacturer name, serial number, and date of calibration.
4. Form of Test Reports: Where the TAB standard being followed recommends a report format use that; otherwise, follow ASHRAE Std 111.
5. Units of Measure: Report data in I-P (inch-pound) units only.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

A. Perform total system balance in accordance with one of the following:
   1. AABC (NSTSB), AABC National Standards for Total System Balance.
   2. SMACNA (TAB).
   3. Maintain at least one copy of the standard to be used at project site at all times.

B. Begin work after completion of systems to be tested, adjusted, or balanced and complete work prior to Substantial Completion of the project.

C. TAB Agency Qualifications:
   1. Company specializing in the testing, adjusting, and balancing of systems specified in this section.
   2. Having minimum of three years documented experience.
   3. Certified by one of the following:
      a. AABC, Associated Air Balance Council: www.aabc.com/#sle; upon completion submit AABC National Performance Guaranty.
      b. NEBB, National Environmental Balancing Bureau: www.nebb.org/#sle.
      c. TABB, The Testing, Adjusting, and Balancing Bureau of National Energy Management Institute: www.tabbcertified.org/#sle.

D. TAB Supervisor and Technician Qualifications: Certified by same organization as TAB agency.

3.02 EXAMINATION

A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:

3.03 PREPARATION

A. Hold a pre-balancing meeting at least one week prior to starting TAB work.

B. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Architect to facilitate spot checks during testing.

3.04 ADJUSTMENT TOLERANCES

A. Air Handling Systems: Adjust to within plus or minus 5 percent of design for supply systems and plus or minus 10 percent of design for return and exhaust systems.

B. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.

C. Hydronic Systems: Adjust to within plus or minus 10 percent of design.

3.05 RECORDING AND ADJUSTING

A. Ensure recorded data represents actual measured or observed conditions.

B. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.

C. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.

D. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

3.06 AIR SYSTEM PROCEDURE

A. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at site altitude.

B. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.

C. Measure air quantities at air inlets and outlets.

D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.

E. Use volume control devices to regulate air quantities only to extend that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.

F. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.

G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.

H. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.

I. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.

J. Where modulating dampers are provided, take measurements and balance at extreme conditions. Balance variable volume systems at maximum air flow rate, full cooling, and at minimum air flow rate, full heating.

K. Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship between each to maintain approximately 0.05 inches positive static pressure near the building entries.

L. For variable air volume system powered units set volume controller to air flow setting indicated. Confirm connections properly made and confirm proper operation for automatic variable air volume temperature control.

3.07 WATER SYSTEM PROCEDURE

A. Adjust water systems to provide required or design quantities.

B. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.

C. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.

D. Effect system balance with automatic control valves fully open to heat transfer elements.

E. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.

F. Where available pump capacity is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.

3.08 SCOPE

A. Test, adjust, and balance the following:

1. HVAC Pumps.
2. Packaged Steel Fire Tube Boilers.

3.09 MINIMUM DATA TO BE REPORTED

A. Pumps:

1. Identification/number.
2. Manufacturer.
3. Size/model.
4. Impeller.
5. Service.
6. Design flow rate, pressure drop, BHP.
7. Actual flow rate, pressure drop, BHP.
8. Discharge pressure.
9. Suction pressure.
10. Total operating head pressure.
11. Shut off, discharge and suction pressures.
12. Shut off, total head pressure.

B. Combustion Equipment:

1. Boiler manufacturer.
2. Model number.
3. Serial number.
4. Firing rate.
5. Overfire draft.
6. Gas meter time per revolution.
7. Gas pressure at meter outlet.
8. Gas flow rate.
9. Heat input.
10. Burner manifold gas pressure.
11. Ambient temperature.
12. Percent combustion efficiency.
13. Heat output.

C. Cooling Tower:

1. Tower identification/number.

2. Manufacturer.
3. Model number.
4. Serial number.
5. Rated capacity.
6. Entering air WB temperature, specified and actual.
7. Leaving air WB temperature, specified and actual.
8. Ambient air DB temperature.
9. Condenser water entering temperature.
10. Condenser water leaving temperature.
11. Condenser water flow rate.
12. Fan RPM.

D. Heat Exchangers:
1. Identification/number.
2. Location.
3. Service.
4. Manufacturer.
5. Model number.
6. Serial number.
7. Primary water entering temperature, design and actual.
8. Primary water leaving temperature, design and actual.
9. Primary water flow, design and actual.
10. Primary water pressure drop, design and actual.
11. Secondary water leaving temperature, design and actual.
12. Secondary water flow, design and actual.
13. Secondary water pressure drop, design and actual.

E. Heating Coils:
1. Identification/number.
2. Location.
3. Service.
4. Manufacturer.
5. Air flow, design and actual.
6. Water flow, design and actual.
7. Water pressure drop, design and actual.
8. Entering water temperature, design and actual.
9. Leaving water temperature, design and actual.
10. Entering air temperature, design and actual.
11. Leaving air temperature, design and actual.
12. Air pressure drop, design and actual.

F. Terminal Unit Data:
   1. Manufacturer.
   2. Type, constant, variable, single, dual duct.
   3. Identification/number.
   4. Location.
   5. Model number.
   6. Size.
   7. Minimum static pressure.
   8. Minimum design air flow.
   9. Maximum design air flow.
   10. Maximum actual air flow.
   11. Inlet static pressure.

END OF SECTION 23-0593

SECTION 23-0719 - HVAC PIPING INSULATION

PART 1 GENERAL

1.01 SUBMITTALS

A. See Section 01-3000 - ADMINISTRATIVE REQUIREMENTS for submittal procedures.

B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

1.02 QUALITY ASSURANCE

1.03 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

1.04 FIELD CONDITIONS

A. Maintain ambient conditions required by manufacturers of each product.

B. Maintain temperature before, during, and after installation for minimum of 24 hours.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

2.02 GLASS FIBER, RIGID

A. Manufacturers:

1. CertainTeed Corporation.
2. Johns Manville Corporation
3. Knauf Insulation.
4. Owens Corning Corporation
5. Substitutions: See Section 01-6000 - PRODUCT REQUIREMENTS.

B. Insulation: ASTM C547 and ASTM C795; semi-rigid, noncombustible, end grain adhered to jacket.

1. K Value: ASTM C177, 0.24 at 75 degrees F.
2. Maximum Service Temperature: 650 degrees F.
3. Maximum Moisture Absorption: 0.2 percent by volume.

C. Vapor Barrier Jacket: White kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E96/E96M of 0.02 perm-inches.

D. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.

PART 3 EXECUTION

3.01 EXAMINATION

A. Test piping for design pressure, liquid tightness, and continuity prior to applying insulation materials.

B. Verify that surfaces are clean and dry, with foreign material removed.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install in accordance with NAIMA National Insulation Standards.

C. Exposed Piping: Locate insulation and cover seams in least visible locations.

D. Insulated Pipes Conveying Fluids Below Ambient Temperature:

1. Insulate entire system, including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.

E. For hot piping conveying fluids 140 degrees F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.

F. For hot piping conveying fluids over 140 degrees F, insulate flanges and unions at equipment.

G. Inserts and Shields:

1. Application: Piping 1-1/2 inches diameter or larger.
2. Insert location: Between support shield and piping and under the finish jacket.
3. Insert Configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
4. Insert Material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range. Wood or other absorptive material is not acceptable.

H. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, see Section 07-8400.

3.03 SCHEDULE

A. Heating Systems: Mineral Fiber Insulation

1. Heating Water Supply and Return:
   a. Pipe size less than or Equal to 1-1/2 inch: 1-1/2 inch thick.
   b. Pipe size greater than 1-1/2 inch: 2 inches thick.

B. Cooling Systems: Mineral Fiber Insulation.

END OF SECTION 23-0719

SECTION 23-0913 - INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Control Valves:
   1. Ball valves with factory-mounted actuators.
B. Thermostats:
   1. Electric thermostats.

1.02 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Conduct a preinstallation meeting one week before starting work of this section; require attendance by all affected installers.

1.03 SUBMITTALS

A. See Section 01-3000 - ADMINISTRATIVE REQUIREMENTS for submittal procedures.
B. Product Data: Provide description and engineering data for each control system component. Include sizing as requested. Provide data for each system component and software module.
C. Shop Drawings: Indicate complete operating data, system drawings, wiring diagrams, and written detailed operational description of sequences. Submit schedule of valves indicating size, flow, and pressure drop for each valve. For automatic dampers indicate arrangement, velocities, and static pressure drops for each system.
D. Operation and Maintenance Data: Include inspection period, cleaning methods, recommended cleaning materials, and calibration tolerances.
E. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.
F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01-6000 - PRODUCT REQUIREMENTS for additional provisions.

1.04 QUALITY ASSURANCE

A. Designer Qualifications: Design system under direct supervision of a Professional Engineer experienced in design of this work and licensed in State Name.

PART 2 PRODUCTS

2.01 EQUIPMENT - GENERAL

A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

2.02 CONTROL VALVES

A. Ball Valves with Factory-Mounted Actuators:
   1. Service: Use for brine (30 percent glycol), chilled water, hot water, or steam at 15 to 25 psig (104.4 to 172.4).
   2. Flow Characteristic: Include 2-way and 3-way diverting operation configured to fail normally closed (NC).
   3. Replacements in Kind: Provide pressure-independent type.

4. Rangeability: 500 to 1.
5. ANSI Rating: Class 150.
6. Leakage: Class IV (0.1 percent of rated capacity) per ANSI/FCI 70-2.
7. Body Size:
    a. Service Temperature:
        1) Fluid Side: 0 to 284 degrees F liquid or 25 psig steam.
        2) Ambient Side: From minus 4 to 122 degrees F.
8. Actuator Requirements:
    a. Assembly: Factory-mounted.
    b. Input: 0 to 5 VDC configured for proportional control.
    c. Accessories: Provide with valve position indicator and manual override.

2.03 THERMOSTATS

A. Electric Thermostats:
1. Type: NEMA BS 31032, 24 volts, with setback/setup temperature control.
2. Service: Cooling and heating.
3. Covers: Locking with set point adjustment, with thermometer.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.
B. Verify that systems are ready to receive work.
C. Beginning of installation means installer accepts existing conditions.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.
B. Check and verify location of thermostats with plans and room details before installation. Locate 60 inches above floor. Align with lighting switches and humidistats; see Section 26-2726.
C. Provide conduit and electrical wiring in accordance with Section 26-0583. Electrical material and installation shall be in accordance with appropriate requirements of Division 26.

3.03 MAINTENANCE

A. Provide service and maintenance of control system for one year from Date of Substantial Completion.
B. Provide complete service of controls systems, including call backs, and submit written report of each service call.
C. In addition to normal service calls, make minimum of ____ complete normal inspections of approximately ____ hours duration to inspect, calibrate, and adjust controls.

END OF SECTION 23-0913

SECTION 23-1123 - FACILITY NATURAL-GAS PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Pipe, pipe fittings, valves, and connections for natural gas piping systems.

1.02 SUBMITTALS

A. See Section 01-3000 - ADMINISTRATIVE REQUIREMENTS, for submittal procedures.

B. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.

C. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. See Section 01-6000 - PRODUCT REQUIREMENTS, for additional provisions.

1.03 QUALITY ASSURANCE

A. Perform work in accordance with applicable codes.

B. Valves: Manufacturer's name and pressure rating marked on valve body.

C. Welding Materials and Procedures: Comply with ASME BPVC-IX and applicable state labor regulations.

D. Welder Qualifications: Certified in accordance with ASME BPVC-IX.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

B. Provide temporary protective coating on cast iron and steel valves.

C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 PRODUCTS

2.01 NATURAL GAS PIPING, ABOVE GRADE

A. Steel Pipe: ASTM A53/A53M, Grade B, Type F, Schedule 40 black.

1. Fittings: ASME B16.3, malleable iron, or ASTM A234/A234M, wrought steel welding type.
2. Joints: Threaded or welded to ASME B31.1.

B. Appliance Flexible Gas Connectors:

1. Corrugated Stainless Steel Tubing with Polymer Coating: Comply with ANSI Z21.24.
2. Fittings: Provide with threaded ends.
3. Operating Pressure rating: 0.5 psig (3.45 kPa).

2.02 FLANGES, UNIONS, AND COUPLINGS

A. Unions for Pipe Sizes 3 Inches and Under:

1. Ferrous Pipe: Class 150 malleable iron threaded unions.

B. Flanges for Pipe Size Over 1 Inch:

1. Ferrous Pipe: Class 150 malleable iron threaded or forged steel slip-on flanges; preformed neoprene gaskets.

2.03 PIPE HANGERS AND SUPPORTS

A. Provide hangers and supports that comply with MSS SP-58.
   1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
   2. Overhead Supports: Individual steel rod hangers attached to structure or to trapeze hangers.
   3. Trapeze Hangers: Welded steel channel frames attached to structure.
   4. Vertical Pipe Support: Steel riser clamp.
   5. Rooftop Supports for NEW Low-Slope Roofs: Galvanized steel curb rail fastener to structure with integral base plate, 2" x 4" wood nailer, and counter flashing.
      a. Height: Minimum 12"
      b. Width: Wide enough to support piping plus 3" on each side of pipe(s).
   6. Rooftop Supports for EXISTING Low-Slope Roofs: Steel pedestals with bases that rest on top of roofing membrane, not requiring any attachment to the roof structure and not penetrating the roofing assembly, with support fixtures as specified; and as follows:
      a. Bases: High density polypropylene.
      b. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
      c. Steel Components: Stainless steel, or carbon steel hot-dip galvanized after fabrication in accordance with ASTM A123/A123M.
      d. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports; corrosion resistant material.
      e. Height: Provide minimum clearance of 6 inches under pipe to top of roofing.
   7. Rooftop Supports for new and Existing Standing Seal Metal Roof: Non-penetrating, alumnium clamp with profile to match metal roofing system, top bolted conenction for pipe clamp, and side set screws to fasten to roof.

2.04 BALL VALVES

A. Construction, 4 Inches and Smaller: MSS SP-110, Class 150, 600 psi CWP, bronze body, chrome plated brass or bronze ball, full port, Teflon seats and stuffing box ring, blow-out proof stem, lever handle, threaded ends with union.

2.05 PLUG VALVES

A. Construction 2 Inches and Smaller: MSS SP-78, 125 psi CWP, bronze body and plug, Threaded or flanged ends, square head or lug type with tamperproof feature, suitable for natural gas service with "WOG" indicated on valve body.

B. Construction 2-1/2 Inches and Larger: MSS SP-78, 125 psi CWP, cast iron body, Bronze or nickel-plated cast iron plug, Teflon or Buna N packing, flanged or threaded ends, square head or lug type with tamperproof feature, suitable for natural gas service with "WO" indicated on valve body.

2.06 STRAINERS

A. Size 2 inch and Under:
   1. Threaded brass body for 125 psi CWP, Y pattern with 1/32 inch stainless steel perforated screen, threaded ends.
B. Size 2-1/2 inch and Larger:
   1. Class 125, flanged iron body, basket pattern with 1/8 inch stainless steel perforated screen, flanged ends

2.07 LINE PRESSURE REGULATORS AND APPLIANCE REGULATORS INDICATORS

A. Manufacturers:
   1. Actaris Metering Systems (A brand of ITT Controls).
   2. Maxitrol Company
   3. American Meter Company.
   4. Invensys
   5. Substitutions: See Section 01-6000 - PRODUCT REQUIREMENTS.
B. Compliance Requirements:
   1. Appliance Regulator: ANSI Z21.18/CSA 6.3.
   2. Line Pressure Regulator: ANSI Z21.80/CSA 6.22.
C. Construction:
   1. Body and Diaphram Case: Cast iron or die-cast alumnium.
   2. Springs: Zinc plated steel.
   3. Diaphram: Zinc plated steel.
   4. Seals: NBR-based rubber.
   5. Orifice: Alumniun: Interchangeable.
D. Pressure regulator shall maintain discharge pressure setting downstream and not exceed 150 percent of design discharge pressure at shutoff.
E. Overprotection Device: Factory mounted on presure regulator.
F. Atmospheric Vent: Factory installed with stainless steel screen.
G. Maximum Inlet Operating Pressure: 10 psi.
   1. Appliance Regulator: 1 psi.
   2. Line Pressure Regulator: 2 psi.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that excavations are to required grade, dry, and not over-excavated.

3.02 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
B. Remove scale and dirt, on inside and outside, before assembly.
C. Prepare piping connections to equipment with flanges or unions.

3.03 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
C. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.
D. Install piping to maintain headroom, conserve space, and not interfere with use of space.
E. Group piping whenever practical at common elevations.
F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 23-0516.
G. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.
H. Install valves with stems upright or horizontal, not inverted.
I. Pipe vents from gas pressure reducing valves to outdoors and terminate in weather proof hood.
J. Pipe Hangers and Supports:
    1. Install in accordance with ASME B31.9.
    2. Support horizontal piping as indicated.
    3. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
    4. Place hangers within 12 inches of each horizontal elbow.
    5. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
    6. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
    7. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

3.04 APPLICATION

A. Install unions downstream of valves and at equipment or apparatus connections.
B. Install ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.
C. Install ball valves for throttling, bypass, or manual flow control services.
D. Provide plug valves in natural gas systems for shut-off service.

END OF SECTION 23-1123

SECTION 23-2113 - HYDRONIC PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Hydronic system requirements.
B. Heating water piping, above grade.
C. Condenser water piping, above grade.
D. Pipe hangers and supports.
E. Unions, flanges, mechanical couplings, and dielectric connections.
F. Valves:

1.02 ADMINISTRATIVE REQUIREMENTS

1.03 SUBMITTALS

A. See Section 01-3000 - ADMINISTRATIVE REQUIREMENTS for submittal procedures.
B. Product Data:
C. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.
D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
    1. See Section 01-6000 - PRODUCT REQUIREMENTS, for additional provisions.

1.04 QUALITY ASSURANCE

1.05 DELIVERY, STORAGE, AND HANDLING

A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.06 FIELD CONDITIONS

A. Do not install underground piping when bedding is wet or frozen.

PART 2 PRODUCTS

2.01 HYDRONIC SYSTEM REQUIREMENTS

A. Comply with ASME B31.9 and applicable federal, state, and local regulations.
B. Piping: Provide piping, fittings, hangers, and supports as required, as indicated, and as follows:
    1. Where more than one piping system material is specified, provide joining fittings that are compatible with piping materials and ensure that the integrity of the system is not jeopardized.
    2. Use non-conducting dielectric connections whenever jointing dissimilar metals.
    3. Grooved mechanical joints may be used in accessible locations only.
        a. Accessible locations include those exposed on interior of building, in pipe chases, and in mechanical rooms, aboveground outdoors, and as approved by Architect.
        b. Use rigid joints unless otherwise indicated.

4. Provide pipe hangers and supports in accordance with ASME B31.9 or MSS SP-58 unless indicated otherwise.

C. Pipe-to-Valve and Pipe-to-Equipment Connections: Use flanges, unions, or grooved couplings to allow disconnection of components for servicing; do not use direct welded, soldered, or threaded connections.

D. Valves: Provide valves where indicated:
1. Provide drain valves where indicated, and if not indicated, provide at least at main shut-off, low points of piping, bases of vertical risers, and at equipment. Use 3/4 inch gate valves with cap; pipe to nearest floor drain.
2. On discharge of condenser water pumps, use spring-loaded check valves.
3. For throttling and isolation service in chilled and condenser water systems, use only butterfly valves.

2.02 HEATING WATER PIPING, ABOVE GRADE

A. Steel Pipe: ASTM A53/A53M, Schedule 40, black, using one of the following joint types:
1. Welded Joints: ASTM A234/A234M, wrought steel welding type fittings; AWS D10.12M/D10.12 welded.
2. Threaded Joints: ASME B16.3, malleable iron fittings.
3. Grooved Joints: AWWA C606 grooved pipe, fittings of same material, and mechanical couplings.

B. Copper Tube: ASTM B88 (ASTM B88M), Type L (B), drawn, using one of the following joint types:
1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings.
a. Solder: ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
b. Braze: AWS A5.8M/A5.8 BCuP copper/silver alloy.
2. Mechanical Press Sealed Fittings: Double pressed type complying with ASME B16.51, utilizing EPDM, nontoxic synthetic rubber sealing elements.

2.03 CONDENSER WATER PIPING, ABOVE GRADE

A. Steel Pipe: ASTM A53/A53M, Schedule 40, black.
1. Welded Joints: ASTM A234/A234M, wrought steel welding type fittings with finish matching piping; AWS D10.12M/D10.12 welded.
2. Threaded Joints: ASME B16.3, malleable iron fittings with finish matching piping.
3. Grooved Joints: AWWA C606 grooved pipe, fittings of same material, and mechanical couplings.

2.04 PIPE HANGERS AND SUPPORTS

A. Provide hangers and supports that comply with MSS SP-58.
1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.

2.05 UNIONS, FLANGES, MECHANICAL COUPLINGS, AND DIELECTRIC CONNECTIONS

A. Unions for Pipe of 2 Inches and Less:
B. Flanges for Pipe 2 Inches and Greater:
C. Mechanical Couplings for Grooved and Shouldered Joints: Two or more curved housing segments with continuous key to engage pipe groove, circular C-profile gasket, and bolts to secure and compress gasket.
    1. Dimensions and Testing: In accordance with AWWA C606.
    2. Mechanical Couplings: Comply with ASTM F1476.
    3. Bolts and Nuts: Hot dipped galvanized or zinc-electroplated steel.
    4. When pipe is field grooved, provide coupling manufacturer's grooving tools.

PART 3 EXECUTION

3.01 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
B. Prepare pipe for grooved mechanical joints as required by coupling manufacturer.
C. Remove scale and dirt on inside and outside before assembly.
D. Prepare piping connections to equipment using jointing system specified.
E. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.
F. After completion, fill, clean, and treat systems. See Section 23-2500 for additional requirements.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.
B. Route piping in orderly manner, parallel to building structure, and maintain gradient.
C. Install piping to conserve building space and to avoid interference with use of space.
D. Group piping whenever practical at common elevations.
E. Slope piping and arrange to drain at low points.
F. Pipe Hangers and Supports:

END OF SECTION 23-2113

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SECTION 23-2114 - HYDRONIC SPECIALTIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Expansion tanks.
B. Air vents.
C. Air separators.
D. Strainers.
E. Suction diffusers.
F. Automatic flow control valves.
G. Relief valves.

1.02 SUBMITTALS

A. See Section 01-3000 - Administrative Requirements for submittal procedures.
B. Product Data: Provide product data for manufactured products and assemblies required for this project. Include component sizes, rough-in requirements, service sizes, and finishes. Include product description and model.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 PRODUCTS

2.01 EXPANSION TANKS

A. Manufacturers:
   1. American Wheatley, a company of Global Flow Products, LLC; _____: www.wheatleyhvac.com/#sle.
   2. Amtrol Inc; _____: www.amtrol.com/#sle.
   3. Bell & Gossett, a brand of Xylem, Inc; _____: www.bellgossett.com/#sle.
   4. Taco, Inc; _____: www.taco-hvac.com/#sle.
   5. Substitutions: See Section 01-6000 - PRODUCT REQUIREMENTS.
B. Maximum Rated Working Pressure: 125 psi.
C. Maximum Allowable Service Temperature: 240 degrees F.
D. Construction: Welded steel, tested and stamped in accordance with ASME BPVC-VIII-1; supplied with National Board Form U-1, adjustable flexible EPDM diaphragm or bladder seal factory precharged to 12 psi, and steel support stand.
E. Automatic Cold Water Fill Assembly: Pressure reducing valve, reduced pressure double check backflow preventer, test cocks, strainer, vacuum breaker, and valved by-pass.

2.02 AIR VENTS

A. Manual Air Vent: Short vertical sections of 2-inch diameter pipe to form air chamber, with 1/8 inch brass needle valve at top of chamber.

B. Float Air Vent:

C. Maximum Fluid Pressure: 150 psi.

D. Maximum Fluid Temperature: 250 degrees F.

2.03 AIR SEPARATORS

A. Coalescing Air/Dirt Separators:

1. Manufacturers:
   a. American Wheatley, a company of Global Flow Products, LLC; _____: www.wheatleyhvac.com/#sle.
   b. Armstrong International, Inc; _____: www.armstronginternational.com/#sle.
   c. Bell & Gossett, a brand of Xylem, Inc; _____: www.bellgossett.com/#sle.
   d. Nexus Valve, Inc; _____: www.nexusvalve.com/#sle.
   e. Spirotherm, Inc; _____: www.spirotherm.com/#sle.
   f. Substitutions: See Section 01-6000 - PRODUCT REQUIREMENTS.
2. Tank: Fabricated steel tank; tested and stamped in accordance with ASME BPVC-VIII-1 for maximum fluid service subject to application requirements and manufacturer's standard maximum operating conditions.
3. Coalescing Medium: Provide structured copper or stainless steel medium filling the entire vessel to suppress turbulence and provide air elimination efficiency of 100 percent free air, 100 percent entrained air, and 99.6 percent dissolved air at the installed location.
4. Air Vent: Integral float actuated air vent at top fitting of tank rated at 150 psi, threaded to top of separator.
5. End Connections: Class 150 flanged for 2-1/2 inch and larger otherwise threaded.
6. Blowdown Connection: Threaded.
7. Size: Match system flow capacity.
8. Maximum Fluid Service Pressure: 150 psi.
9. Maximum Fluid Service Temperature: 250 degrees F.

2.04 STRAINERS

A. Size 2 inch and Under:

1. Provide threaded, grooved, or sweat brass or iron body for up to 175 psi working pressure, Y-pattern strainer with 1/32 inch stainless steel perforated screen.

B. Size 2-1/2 inch to 4 inch:

1. Provide flanged or grooved iron body for up to 175 psi working pressure, up to 250 degrees F working temperature, Y-pattern strainer with 1/16 inch or 3/64 inch stainless steel perforated screen.

2.05 SUCTION DIFFUSERS

2.06 PUMP CONNECTORS

A. Flexible Connectors: Flanged, braided type with wetted components of stainless steel, sized to match piping.
   1. Maximum Operating Service: 150 psi at 120 degrees F.
   2. Accommodate the Following:
      a. Axial Deflection in Compression and Expansion: _____ inch.
      b. Lateral Movement: _____ inch.
      c. Angular Rotation: 15 degrees.
      d. Force developed by 1.5 times specified maximum allowable operating pressure.
   3. End Connections: Same as specified for pipe jointing.
   4. Provide necessary accessories including, but not limited to, swivel joints.

2.07 AUTOMATIC FLOW CONTROL VALVES

A. Manufacturers:
B. Construction:
   1. Brass, bronze, or iron body with union on inlet and outlet, temperature and pressure test plug on inlet and outlet with blowdown/backflush drain.
   2. Built-in lug-type outlet butterfly valve with 2-position handle.
C. Calibration: Control flow within 10 percent of selected rating, over operating pressure range of 10 times minimum pressure required for control, minimum pressure 2 psi.
D. Control Mechanism: Provide stainless steel or nickel-plated, brass piston or regulator cup, operating against stainless steel helical or wave formed spring or elastomeric diaphragm and polyphenylsulfone orifice plate.

2.08 RELIEF VALVES

A. Bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labelled.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install specialties in accordance with manufacturer's instructions.
B. Provide manual air vents at system high points and as indicated.
C. For automatic air vents in ceiling spaces or other concealed locations, provide vent tubing to nearest drain.
D. Provide air separator on suction side of system circulation pump and connect to expansion tank.
E. Provide valved drain and hose connection on strainer blowdown connection.
F. Provide pump suction fitting on suction side of base-mounted centrifugal pumps where indicated. Remove temporary strainers after cleaning systems.
G. Support pump fittings with floor-mounted pipe and flange supports.
H. Provide relief valves on pressure tanks, low-pressure side of reducing valves, heat exchangers, and expansion tanks.
I. Pipe relief valve outlet to nearest floor drain.

END OF SECTION 23-2114

SECTION 23-2123 - HYDRONIC PUMPS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. In-line pumps.

B. End-suction pumps.

1.02 SUBMITTALS

A. See Section 01-3000 - ADMINISTRATIVE REQUIREMENTS for submittal procedures.

B. Product Data: Provide certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and connection requirements.

C. Operation and Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. See Section 01-6000 - PRODUCT REQUIREMENTS, for additional provisions.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Armstrong Fluid Technology, Inc: www.armstrongfluidtechnology.com/#sle.

B. Bell & Gossett, a Xylem Inc. brand: www.bellgossett.com/#sle.

C. SIHI Group: www.sterlingsihi.com/#sle.

D. [Grundfos pumps Corporation.].

E. [ITT Corporation; Bell & Gossett.].

F. [PACO Pumps.].

G. [TACO Incorporated.].

H. [Thrush Company Inc.].

I. [Little Giant Pump Co.].

J. Substitutions: See Section 01-6000 - PRODUCT REQUIREMENTS.

2.02 GENERAL

A. Provide pumps that operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.

B. Electrical Requirements:

1. Listed and classified by UL or testing agency acceptable to authority having jurisdiction as suitable for the purpose specified and indicated.

2. Variable Frequency Drives (VFDs): Provide in accordance with Section 23-0934, except for integral-VFDs.

3. Enclosures: Provide unspecified product(s) required to fit motor:

2.03 IN-LINE PUMPS

A. Casing: Cast iron with seal flush connection, flanged suction, and discharge ports with gauge port and drain plug.
B. Impeller: Stainless steel, fully enclosed, keyed directly to motor shaft or extension.
C. Shaft: Stainless steel with stainless steel impeller cap screw or nut and bronze sleeve.
D. Seal: Mechanical seal, 225 degrees F maximum continuous duty temperature.

2.04 END-SUCTION PUMPS

A. Split-Coupled Pump: Base-mounted, single-stage pump with horizontal shaft and radially- or horizontally-split casing rated for discharge pressures up to 175 psi.
B. Casing: Cast iron or ductile iron with renewable bronze casing wearing rings, seal flush connection, drain plug, flanged suction, and discharge flanged connections with gauge ports.
C. Impeller: Stainless steel, balanced, fully enclosed, keyed to shaft.
D. Bearings: Oil lubricated roller or ball bearings.
E. Shaft: Alloy steel with copper, bronze, or stainless steel shaft sleeve.
F. Drive: Flexible coupling with coupling guard.
G. Baseplate: Cast iron or fabricated steel with integral drain rim.

PART 3 EXECUTION

3.01 PREPARATION

A. Verify that electric power is available and of the correct characteristics.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.
B. Provide access space around pumps for service. Provide no less than minimum space recommended by manufacturer.
C. Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump such that no weight is carried on pump casings. For close-coupled or base-mounted pumps, provide supports under elbows on pump suction and discharge line sizes 4 inches and over.
D. Provide line sized shut-off valve and strainer on pump suction, and line sized soft seat check valve and balancing valve on pump discharge.
E. Check, align, and certify alignment of base-mounted pumps prior to start-up.
F. Lubricate pumps before start-up.
G. Controls: Interface each pump starter or VFD.

END OF SECTION 23-2123

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SECTION 23-5216 - CONDENSING BOILERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Manufactured units.
B. Boiler construction.
C. Boiler trim.
D. Fuel burning system.
E. Factory installed controls.

1.02 ADMINISTRATIVE REQUIREMENTS

1.03 SUBMITTALS

A. See Section 01-3000 - ADMINISTRATIVE REQUIREMENTS for submittals procedures.
B. Product Data: Provide data indicating general assembly, components, controls, safety controls, and wiring diagrams with electrical characteristics and connection requirements, and service connections.
C. Manufacturer's Factory Inspection Report: Submit boiler inspection prior to shipment.
D. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, cleaning procedures, replacement parts list, and maintenance and repair data.
E. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum _____ years of documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Protect boilers from damage by leaving factory inspection openings and shipping packaging in place until final installation.

1.06 WARRANTY

A. See Section 01-7800 - CLOSEOUT SUBMITTALS for additional warranty requirements.
B. Provide a five year warranty to include coverage for heat exchanger.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Natural Gas, Propane, or Combination Natural Gas/Propane for Indoor Applications:
   1. Bosch Thermotechnology; _____: www.bosch-thermotechnology.us/#sle.
   2. Bradford White Corporation; _____: www.bradfordwhite.com/#sle.
   3. LAARS Heating Systems Company; _____: www.laars.com/#sle.
   4. Lochinvar LLC; _____: www.lochinvar.com/#sle.
   5. The Fulton Companies; _____: www.fulton.com/#sle.
   6. Substitutions: See Section 01-6000 - PRODUCT REQUIREMENTS.

2.02 MANUFACTURED UNITS

A. Factory assembled, factory fire-tested, self-contained, readily transported unit ready for automatic operation except for connection of water, fuel, electrical, and vent services.

B. Unit: Metal membrane wall, water or fire tube, condensing boiler on integral structural steel frame base with integral fuel burning system, firing controls, boiler trim, insulation, and removable jacket, suitable for indoor application.

2.03 BOILER CONSTRUCTION

A. Comply with the minimum requirements of ASME BPVC-IV and ANSI Z21.13 for construction of boilers.

B. Assembly to bear the ASME "H" stamp and comply with the efficiency requirements of the latest edition of ASHRAE Std 90.1 I-P.

C. Required Directory Listings:

1. AHRI Directory of Certified Product Performance - Air-Conditioning, Heating, and Refrigeration Institute (AHRI).
2. NBBI Manufacturer and Repair Directory - The National Board of Boiler and Pressure Vessel Inspectors (NBBI).

D. Heat Exchanger: Construct with materials that are impervious to corrosion where subject to contact with corrosive condensables.

E. Provide adequate tappings, observation ports, removable panels, and access doors for entry, cleaning, and inspection.

F. Insulate casing with insulation material, protected and covered by heavy-gauge metal jacket.

G. Factory apply boiler base and other components, that are subject to corrosion, with durable, acrylic, powder coated, painted, or weather-proofed finish.

2.04 BOILER TRIM

A. ASME rated pressure relief valve.

B. Flow switch.

C. Electronic Low Water Cut-off: Complete with test light and manual reset button to automatically prevent firing operation whenever boiler water falls below safe level.

D. Temperature and pressure gauge.

E. Pressure Switches:

1. High gas pressure.
2. Low gas pressure.
3. Air pressure.

F. Manual reset high limit.

G. Boiler Pump (where required by boiler design):

1. Primary pump, factory supplied and sized for field installation to ensure minimum, continuous circulation through boiler.
2. Where pump is not provided by boiler manufacturer, provide pump in accordance with boiler manufacturer's recommendations.
3. Pump time delay.

2.05 FUEL BURNING SYSTEM

A. Provide forced draft automatic burner or pulse combustion, integral to boiler, designed to burn natural gas, and maintain fuel-air ratios automatically.
   1. Blower Design: Statically and dynamically balanced to supply combustion air; direct connected to motor.
   2. Forced Draft Design: Mixes combustion air and gas to achieve 90 percent combustion efficiency.
   3. Pulse Combustion Design: Self-aspirating, not requiring blower for combustion.
   4. Combustion Air Filter: Protects fuel burning system from debris.

B. Gas Train: Plug valve, safety gas valve, gas-air ratio control valve, and pressure regulator controls air and gas mixture.

C. Emission of Oxides of Nitrogen Requirements: Comply with SCAQMD 1146.1 for natural gas fired system, as applicable.

D. Intakes: Combustion air intake capable of accepting free mechanical room air or direct outside air through a sealed intake pipe.

2.06 FACTORY INSTALLED CONTROLS

A. Option for internal or external (0-10) VDC control.

B. Temperature Controls:
   1. Automatic reset type to control fuel burning system on-off and firing rate to maintain temperature.
   2. Manual reset type to control fuel burning system to prevent boiler water temperature from exceeding safe system water temperature.
   3. Low-fire start time delay relay.

C. Electronic PI setpoint/modulation control system.

D. Microprocessor-based, fuel/air mixing controls.

E. BAS, SCADA, or other Integrated Automation Link: ASHRAE Std 135 BACnet MS/TP.
   1. External Point Mapping: Provide mapping table for each parameter included in the local visual interface with software-toggle flag to allow reduced mapping of available points.

2.07 SOURCE QUALITY CONTROL

A. See Section 01-4000 - QUALITY REQUIREMENTS for additional requirements.

B. Provide factory tests to check construction, controls, and operation of unit.

C. Manufacturer to conduct boiler inspection prior to shipment; submit copy of inspection report to Architect.

D. Non-Complying Work: See Section 01-4000.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install boiler and provide connection of natural gas service in accordance with requirements of NFPA 54 and applicable codes.

C. Install boiler on concrete housekeeping base, sized minimum of 4 inches larger than boiler base.

D. Pipe relief valves to nearest floor drain.

E. Pipe cooled condensate produced by the combustion process from the boiler condensate connection and/or flue stack with suitable piping material to neutralizer prior to discharging into nearest floor drain.

F. Connect vent combustion generated fumes to breeching, chimney or exhaust stack; see

3.02 CLOSEOUT ACTIVITIES

A. See Section 01-7800 - CLOSEOUT SUBMITTALS for closeout submittals.

B. Training: Train Owner's personnel on operation and maintenance of system.

1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
2. Provide minimum of two hours of training.
3. Instructor: Manufacturer's training personnel.
4. Location: At project site.

END OF SECTION 23-5216

SECTION 23-5700 - HEAT EXCHANGERS FOR HVAC

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Plate type heat exchangers.

1.02 SUBMITTALS

A. See Section 01-3000 - ADMINISTRATIVE REQUIREMENTS for submittal procedures.

B. Product Data: Provide data with dimensions, locations, and size of tappings and performance data.

C. Shop Drawings: Indicate dimensions, locations, and size of tappings and performance data.

D. Operation and Maintenance Data: Include start up and shut down instructions, assembly drawings, and spare parts lists.

E. Warranty: Submit manufacturer's warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. See Section 01-6000 - PRODUCT REQUIREMENTS for additional provisions.
2. Extra Gaskets: One set of each type and size.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Protect internals from entry of foreign material by temporary caps on flanged openings.

1.04 WARRANTY

A. See Section 01-7800 - CLOSEOUT SUBMITTALS for additional warranty requirements.

B. Provide five year manufacturer warranty for heat exchangers.

PART 2 PRODUCTS

2.01 PLATE AND FRAME TYPE HEAT EXCHANGER

A. Manufacturers:

1. [APV; a brand of SPX Corporation.].
2. [Delta T Heat Exchangers.].
3. [GEA PHE Systems North America Inc.].
4. [ITT Corporation; Bell & Gossett.].
5. [Mueller, Paul, Company.].
6. [Polaris Plate Heat Exchangers.].
7. [SEC Heat Exchangers.].
8. [Thermo Dynamics Ltd.].
9. Substitutions: See Section 01-6000 - PRODUCT REQUIREMENTS.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Support heat exchangers on concrete housekeeping pad.

C. Pipe relief valves to nearest floor drain.

D. Pipe drain valves to nearest floor drain.

3.02 WATER TO WATER HEAT EXCHANGER TRIM

A. Water Inlets and Outlets: Thermometer wells, pressure gauge tappings.

END OF SECTION 23-5700

SECTION 23-6513 - FORCED-DRAFT COOLING TOWERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Forced-draft cooling towers.

B. Controls.

1.02 SUBMITTALS

A. See Section 01-3000 - ADMINISTRATIVE REQUIREMENTS for submittal procedures.

B. Product Data: Provide rated capacities, dimensions, weights and point loadings, accessories, required clearances, electrical requirements and wiring diagrams, and location and size of field connections. Submit schematic indicating capacity controls.

C. Shop Drawings: Indicate suggested structural steel supports including dimensions, sizes, and locations for mounting bolt holes.

D. Manufacturer's Certificate: Certify that cooling tower performance, based on ASME PTC 23 meets or exceeds specified requirements and submit performance curve plotting leaving water temperature against wet bulb temperature.

E. Manufacturer's Instructions: Submit manufacturer's complete installation instructions.

F. Operation and Maintenance Data: Include start-up instructions, maintenance data, parts lists, controls, and accessories.

G. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. See Section 01-6000 - PRODUCT REQUIREMENTS, for additional provisions.
2. Extra Fan Belts: One set, matched, for each unit.
3. Extra Spray Nozzles: One for each cell.
4. Extra Valve Seats: One for each make-up valve and control valve.

1.03 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum five years of documented experience.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Factory assemble complete unit. For shipping, disassemble into as large as practical sub-assemblies so that minimum amount of field work is required for re-assembly.

B. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.

1.05 WARRANTY

A. See Section 01-7800 - CLOSEOUT SUBMITTALS, for additional warranty requirements.

B. Provide a five year warranty to include labor and materials coverage for corrosion resistance of cooling tower structure.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Baltimore Aircoil Company; _____: www.baltimoreaircoil.com/#sle.
B. EVAPCO, Inc; _____: www.evapco.com/#sle.
C. SPX Cooling Technologies/Marley; _____: www.spxcooling.com/#sle.
D. Substitutions: See Section 01-6000 - PRODUCT REQUIREMENTS.

2.02 FORCED-DRAFT COOLING TOWERS

A. General Requirements:
   1. Provide units for outdoor use, factory assembled, sectional, counterflow, vertical discharge, blow-through design, with fan assemblies built into pan and casing.
   2. Products Requiring Electrical Connection: Listed and classified by UL (DIR) as suitable for purpose specified and indicated.
   3. Unit is to consist of all-stainless steel construction option.
B. Basis of Design: Open-Circuit, Forced-Draft, Counter-Flow Cooling Tower: Baltimore Aircoil Company; Series V: www.baltimoreaircoil.com/#sle.
   1. Cold Water Basin:
      a. Heavy-gage 316 stainless steel with all edges given a protective coating of zinc-rich compound. Basin will include large area lift out strainers with perforated openings sized smaller than the water distribution system nozzles and an anti-votexing device to prevent air entrainment. The strainer and anti-vortexing device will be constructed of the same material as the basin to prevent dissimilar metal corrosion. Provide drain/clean-out connection. Basins constructed of 301 or 304 stainless steel are not acceptable.
   2. Heat Transfer Coils:
      a. ASME Coils:
         1) Coil to comply with ASME BPVC-VIII-1 and bear U stamp.
   3. Motor: Two speed mounted on adjustable steel base.
   4. Belt Drive: Designed for minimum 150 percent motor nameplate power.
   5. Fan Guard: Welded steel rod and wire guard, hot-dipped-galvanized after fabrication.
   6. Safety: Safety railings, and ladder with safety cage from grade to fan deck.
   7. Distribution Section: Polyvinyl chloride piping header and branches with ABS plastic spray nozzles.
   8. Fill:
      a. Self-supporting, fluted polyvinyl chloride plastic with flame spread index of 5 or less, when tested in accordance with ASTM E84.
      b. Fungal Resistance: No growth when tested in accordance with ASTM G21.
   9. Float Valves: Brass or bronze, balanced-piston type make-up valve with plastic or copper float.
   10. Hardware: Stainless steel nuts, bolts, washers, and nails; assembled with phenolic-epoxy-coated, corrosion-resistant washer head fasteners.

11. Galvanized Steel Sheet Components: Hot-dipped-galvanized steel, ASTM A653/A653M, with G210/Z600 coating, and finished with zinc-chromatized-aluminum paint.
12. Steel Angles, Plates, Bars, and Shapes: Galvanized after fabrication to comply with ASTM A123/A123M, Coating Thickness Grade 100.

2.03 CONTROLS

A. Electric Temperature Controller: In pan; with sensor to cycle fans.
B. Time Delay Relay: Limits fan motor starts to not more than six per hour.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.
B. Provide the services of the manufacturer's field representative to supervise rigging, hoisting, and installation, allowing for minimum of one 8-hour day per tower.
C. Install tower on structural steel beams as instructed by manufacturer.
D. Connect condenser water piping with flanged connections to tower. Pitch condenser water supply to tower and condenser water suction away from tower. See Section 23-2113.

3.02 FIELD QUALITY CONTROL

A. See Section 01-4000 - QUALITY REQUIREMENTS, for additional requirements.
B. Provide the services of the manufacturer's field representative to inspect tower after installation and submit report prior to start-up, verifying installation is in accordance with specifications and manufacturer's recommendations.

3.03 SYSTEM STARTUP

A. Start-up tower in presence of and instruct Owner's operating personnel.

END OF SECTION 23-6513

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SECTION 26-0519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Single conductor building wire.
B. Variable-frequency drive cable.
C. Wiring connectors.
D. Electrical tape.
E. Wire pulling lubricant.

1.02 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate sizes of raceways, boxes, and equipment enclosures installed under other sections with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
   2. Coordinate with electrical equipment installed under other sections to provide terminations suitable for use with the conductors to be installed.
   3. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.03 SUBMITTALS

A. See Section 01-3000 - ADMINISTRATIVE REQUIREMENTS, for submittal procedures.
B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conductors and cables, including detailed information on materials, construction, ratings, listings, and available sizes, configurations, and stranding.
C. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01-6000 - PRODUCT REQUIREMENTS, for additional provisions.

1.04 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store conductors and cables in accordance with manufacturer's instructions.

1.06 FIELD CONDITIONS

A. Do not install or otherwise handle thermoplastic-insulated conductors at temperatures lower than 14 degrees F, unless otherwise permitted by manufacturer's instructions. When installation below this temperature is unavoidable, notify Architect and obtain direction before proceeding with work.

PART 2 PRODUCTS

2.01 CONDUCTOR AND CABLE APPLICATIONS

A. Do not use conductors and cables for applications other than as permitted by NFPA 70 and product listing.

B. Provide single conductor building wire installed in suitable raceway unless otherwise indicated, permitted, or required.

2.02 CONDUCTOR AND CABLE GENERAL REQUIREMENTS

A. Provide products that comply with requirements of NFPA 70.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.

D. Comply with NEMA WC 70.

E. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.

F. Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with UL 44.

G. Conductor Material:

1. Provide copper conductors only. Aluminum conductors are not acceptable for this project. Conductor sizes indicated are based on copper.
2. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B787M unless otherwise indicated.
3. Tinned Copper Conductors: Comply with ASTM B33.

H. Conductor Color Coding:

1. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.
2. Color Coding Method: Integrally colored insulation.
3. Color Code:
   a. 480Y/277 V, 3 Phase, 4 Wire System:
      1) Phase A: Brown.
      2) Phase B: Orange.
      3) Phase C: Yellow.
      4) Neutral/Grounded: Gray.
   b. 208Y/120 V, 3 Phase, 4 Wire System:
      1) Phase A: Black.
      2) Phase B: Red.
      3) Phase C: Blue.
      4) Neutral/Grounded: White.
   c. Equipment Ground, All Systems: Green.
   d. For modifications or additions to existing wiring systems, comply with existing color code when existing code complies with NFPA 70 and is approved by the authority having jurisdiction.

2.03 SINGLE CONDUCTOR BUILDING WIRE

A. Description: Single conductor insulated wire.

B. Conductor Stranding:

1. Feeders and Branch Circuits:
    a. Size 10 AWG and Smaller: Solid.
    b. Size 8 AWG and Larger: Stranded.

C. Insulation Voltage Rating: 600 V.

D. Insulation:
1. Copper Building Wire: Type THHN/THWN or THHN/THWN-2.

2.04 VARIABLE-FREQUENCY DRIVE CABLE

A. Description: Flexible motor supply cable listed and labeled as complying with UL 2277 in accordance with NFPA 79; specifically designed for use with variable frequency drives and associated nonlinear power distortions.

B. Conductor Stranding: Stranded.

C. Insulation Voltage Rating: 1000 V.

D. Insulation: Use only thermoset insulation types; thermoplastic insulation types are not permitted.

E. Grounding: Full-size integral equipment grounding conductor or symmetrical arrangement of multiple conductors of equivalent size.

F. Provide metallic shielding.

G. Jacket: PVC or Chlorinated Polyethylene (CPE).

2.05 WIRING CONNECTORS

A. Description: Wiring connectors appropriate for the application, suitable for use with the conductors to be connected, and listed as complying with UL 486A-486B or UL 486C as applicable.

B. Wiring Connectors for Splices and Taps:
1. Copper Conductors Size 8 AWG and Smaller: Use twist-on insulated spring connectors.
2. Copper Conductors Size 6 AWG and Larger: Use mechanical connectors or compression connectors.

C. Wiring Connectors for Terminations:
1. Provide terminal lugs for connecting conductors to equipment furnished with terminations designed for terminal lugs.
2. Provide compression adapters for connecting conductors to equipment furnished with mechanical lugs when only compression connectors are specified.
3. Provide motor pigtail connectors for connecting motor leads in order to facilitate disconnection.
4. Stranded Conductors Size 10 AWG and Smaller: Use crimped terminals for connections to terminal screws.

D. Do not use insulation-piercing or insulation-displacement connectors designed for use with conductors without stripping insulation.

E. Do not use push-in wire connectors as a substitute for twist-on insulated spring connectors.

F. Twist-on Insulated Spring Connectors: Rated 600 V, 221 degrees F for standard applications and 302 degrees F for high temperature applications; pre-filled with sealant and listed as complying with UL 486D for damp and wet locations.

G. Mechanical Connectors: Provide bolted type or set-screw type.

H. Compression Connectors: Provide circumferential type or hex type crimp configuration.

I. Crimped Terminals: Nylon-insulated, with insulation grip and terminal configuration suitable for connection to be made.

2.06 ACCESSORIES

A. Electrical Tape:

1. Vinyl Insulating Electrical Tape: Complying with ASTM D3005 and listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; conformable for application down to 0 degrees F and suitable for continuous temperature environment up to 221 degrees F.

B. Wire Pulling Lubricant:

1. Listed and labeled as complying with UL 267.
2. Suitable for use with conductors/cables and associated insulation/jackets to be installed.
3. Suitable for use at installation temperature.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that work likely to damage wire and cable has been completed.

B. Verify that raceways, boxes, and equipment enclosures are installed and are properly sized to accommodate conductors and cables in accordance with NFPA 70.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

A. Clean raceways thoroughly to remove foreign materials before installing conductors and cables.

3.03 INSTALLATION

A. Circuiting Requirements:

1. Unless dimensioned, circuit routing indicated is diagrammatic.
2. When circuit destination is indicated without specific routing, determine exact routing required.
3. Arrange circuiting to minimize splices.
4. Maintain separation of wiring for emergency systems in accordance with NFPA 70.
5. Common Neutrals: Unless otherwise indicated, sharing of neutral/grounded conductors among up to three single phase branch circuits of different phases installed in the same raceway is not permitted. Provide dedicated neutral/grounded conductor for each individual branch circuit.

B. Install products in accordance with manufacturer's instructions.

C. Perform work in accordance with NECA 1 (general workmanship).

D. Installation in Raceway:

1. Tape ends of conductors and cables to prevent infiltration of moisture and other contaminants.
2. Pull all conductors and cables together into raceway at same time.
3. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.
4. Use suitable wire pulling lubricant where necessary, except when lubricant is not recommended by the manufacturer.

E. Paralleled Conductors: Install conductors of the same length and terminate in the same manner.

F. Secure and support conductors and cables in accordance with NFPA 70 using suitable supports and methods approved by the authority having jurisdiction. Provide independent support from building structure. Do not provide support from raceways, piping, ductwork, or other systems.

G. Variable-Frequency Drive Cable: Terminate shielding at both variable-frequency motor controller and associated motor using glands or termination kits recommended by manufacturer.

H. Install conductors with a minimum of 12 inches of slack at each outlet.

I. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.

J. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.

K. Make wiring connections using specified wiring connectors.

1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies or wiring gutters.
2. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.
3. Do not remove conductor strands to facilitate insertion into connector.
4. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminates. Do not use wire brush on plated connector surfaces.
5. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
6. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.

L. Insulate splices and taps that are made with uninsulated connectors using methods suitable for the application, with insulation and mechanical strength at least equivalent to unspliced conductors.

M. Insulate ends of spare conductors using vinyl insulating electrical tape.

N. Install firestopping to preserve fire resistance rating of partitions and other elements07-8400.

O. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.

3.04 FIELD QUALITY CONTROL

A. See Section 01-4000 - QUALITY REQUIREMENTS, for additional requirements.
B. Inspect and test in accordance with NETA ATS, except Section 4.
C. Correct deficiencies and replace damaged or defective conductors and cables.

END OF SECTION 26-0519

SECTION 26-0529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Support and attachment requirements and components for equipment, conduit, cable, boxes, and other electrical work.

1.02 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate sizes and arrangement of supports and bases with actual equipment and components to be installed.
   2. Coordinate work to provide additional framing and materials required for installation.
   3. Coordinate compatibility of support and attachment components with mounting surfaces at installed locations.
   4. Coordinate arrangement of supports with ductwork, piping, equipment and other potential conflicts.
   5. Notify Architect of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:
   1. Do not install products on or provide attachment to concrete surfaces until concrete has cured; see Section 03-3000.

1.03 SUBMITTALS

A. See Section 01-3000 - ADMINISTRATIVE REQUIREMENTS for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for channel/strut framing systems and post-installed concrete/masonry anchors.

1.04 QUALITY ASSURANCE

A. Product Listing Organization Qualifications: Organization recognized by OSHA as Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 SUPPORT AND ATTACHMENT COMPONENTS

A. General Requirements:
   1. Comply with the following. Where requirements differ, comply with most stringent.
      a. NFPA 70.
      b. Requirements of authorities having jurisdiction.
   2. Provide required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for complete installation of electrical work.
   3. Provide products listed, classified, and labeled as suitable for purpose intended, where applicable.

4. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for load to be supported. Include consideration for vibration, equipment operation, and shock loads where applicable.
5. Do not use products for applications other than as permitted by NFPA 70 and product listing.
6. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
7. Steel Components: Use corrosion-resistant materials suitable for environment where installed.
    a. Indoor Dry Locations: Use zinc-plated steel or approved equivalent unless otherwise indicated.
    b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel, stainless steel, or approved equivalent unless otherwise indicated.
    c. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
    d. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.

B. Conduit and Cable Supports: Straps and clamps suitable for conduit or cable to be supported.
1. Conduit Straps: One-hole or two-hole type; steel or malleable iron.
2. Conduit Clamps: Bolted type unless otherwise indicated.

C. Outlet Box Supports: Hangers and brackets suitable for boxes to be supported.

D. Metal Channel/Strut Framing Systems:
1. Description: Factory-fabricated, continuous-slot, metal channel/strut and associated fittings, accessories, and hardware required for field assembly of supports.
2. Comply with MFMA-4.
3. Channel Material:
    a. Indoor Dry Locations: Use painted steel, zinc-plated steel, or galvanized steel.
    b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel.

E. Hanger Rods: Threaded, zinc-plated steel unless otherwise indicated.

F. Anchors and Fasteners:
1. Unless otherwise indicated and where not otherwise restricted, use anchor and fastener types indicated for specified applications.
2. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
3. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
4. Hollow Masonry: Use toggle bolts.
5. Hollow Stud Walls: Use toggle bolts.
6. Steel: Use beam clamps, machine bolts, or welded threaded studs.
7. Powder-actuated fasteners are not permitted.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that mounting surfaces are ready to receive support and attachment components.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install hangers and supports in accordance with NECA 1.

C. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.

D. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.

E. Unless specifically indicated or approved by Architect, do not provide support from roof deck.

F. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.

G. Equipment Support and Attachment:

1. Use metal, fabricated supports or supports assembled from metal channel/strut to support equipment as required.
2. Use metal channel/strut secured to studs to support equipment surface mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
3. Use metal channel/strut to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.

H. Secure fasteners in accordance with manufacturer's recommended torque settings.

I. Remove temporary supports.

3.03 FIELD QUALITY CONTROL

A. See Section 01-4000 - QUALITY REQUIREMENTS for additional requirements.

B. Inspect support and attachment components for damage and defects.

C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

D. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION 26-0529

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SECTION 26-0533.13 - CONDUIT FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Galvanized steel rigid metal conduit (RMC).
B. Galvanized steel intermediate metal conduit (IMC).
C. Flexible metal conduit (FMC).
D. Liquidtight flexible metal conduit (LFMC).
E. Galvanized steel electrical metallic tubing (EMT).
F. Liquidtight flexible nonmetallic conduit (LFNC).

1.02 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate minimum sizes of conduits with actual type and quantity of conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
   2. Coordinate arrangement of conduits with structural members, ductwork, piping, equipment, and other potential conflicts.
   3. Verify exact conduit termination locations required for boxes, enclosures, and equipment.
   4. Coordinate work to provide roof penetrations that preserve integrity of roofing system and do not void roof warranty.
   5. Notify Architect of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
B. Sequencing:
   1. Do not begin installation of conductors and cables until installation of conduit between termination points is complete.

1.03 SUBMITTALS

A. See Section 01-3000 - ADMINISTRATIVE REQUIREMENTS for submittals procedures.
B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conduits and fittings.

1.04 QUALITY ASSURANCE

A. Product Listing Organization Qualifications: Organization recognized by OSHA as Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store conduit and fittings in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 CONDUIT APPLICATIONS

A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70, manufacturer's instructions, and product listing.

B. Unless otherwise indicated and where not otherwise restricted, use conduit types indicated for specified applications. Where more than one listed application applies, comply with most restrictive requirements. Where conduit type for particular application is not specified, use galvanized steel rigid metal conduit.

C. Exposed, Interior, Not Subject to Physical Damage: Use galvanized steel electrical metallic tubing (EMT).

D. Exposed, Exterior, Not Subject to Severe Physical Damage: Use galvanized steel electrical metallic tubing (EMT).

E. Exposed, Exterior, Subject to Severe Physical Damage: Use galvanized steel rigid metal conduit (RMC) or galvanized steel intermediate metal conduit (IMC).

F. Flexible Connections to Vibrating Equipment:

1. Dry Locations: Use flexible metal conduit (FMC).
2. Damp, Wet, or Corrosive Locations: Use liquidtight flexible metal conduit (LFMC).
3. Maximum Length: 6 feet unless otherwise indicated.
4. Vibrating equipment includes, but is not limited to:
   a. Motors.

2.02 CONDUIT - GENERAL REQUIREMENTS

A. Comply with NFPA 70.

B. Existing Work: Where existing conduits are indicated to be reused, they may be reused only where they comply with specified requirements, are free from corrosion, and integrity is verified by pulling mandrel through them.

C. Provide conduit, fittings, supports, and accessories required for complete raceway system.

D. Provide products listed, classified, and labeled as suitable for purpose intended.

E. Minimum Conduit Size, Unless Otherwise Indicated:

1. Branch Circuits: 3/4-inch trade size.
2. Branch Circuit Homeruns: 3/4-inch trade size.

F. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

2.03 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

A. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.

B. Fittings:

1. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 6.
2. Material: Use steel or malleable iron.
3. Connectors and Couplings: Use threaded type fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.

2.04 GALVANIZED STEEL INTERMEDIATE METAL CONDUIT (IMC)

A. Description: NFPA 70, Type IMC galvanized steel intermediate metal conduit complying with ANSI C80.6 and listed and labeled as complying with UL 1242.

B. Fittings:

1. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 1242.
2. Material: Use steel or malleable iron.
3. Connectors and Couplings: Use threaded type fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.

2.05 FLEXIBLE METAL CONDUIT (FMC)

A. Description: NFPA 70, Type FMC standard-wall steel flexible metal conduit listed and labeled as complying with UL 1, and listed for use in classified firestop systems.

B. Fittings:

1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
2. Material: Use steel or malleable iron.

2.06 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

A. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.

B. Fittings:

1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
2. Material: Use steel or malleable iron.

2.07 GALVANIZED STEEL ELECTRICAL METALLIC TUBING (EMT)

A. Description: NFPA 70, Type EMT galvanized steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.

B. Fittings:

1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
2. Material: Use steel or malleable iron.
3. Connectors and Couplings: Use compression/gland or set-screw type.
   a. Do not use indenter type connectors and couplings.

2.08 LIQUIDTIGHT FLEXIBLE NONMETALLIC CONDUIT (LFNC)

A. Description: NFPA 70, Type LFNC liquidtight flexible nonmetallic conduit listed and labeled as complying with UL 1660.

B. Fittings:

1. Manufacturer: Same as manufacturer of conduit to be connected.
2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B; suitable for type of conduit to be connected.

2.09 ACCESSORIES

A. Conduit Joint Compound: Corrosion-resistant, electrically conductive compound listed as complying with UL 2419; suitable for use with conduit to be installed.
B. Pull Strings: Use nylon or polyester tape with average breaking strength of not less than 1,250 lbf.
C. Foam Conduit Sealant:
    1. Removable, two-part, closed-cell foam, specifically designed for sealing conduit openings against water, moisture, gases, and dust.
    2. Suitable for use with conductors/cables and associated insulation/jackets to be installed.
    3. Rated to hold minimum of 10 ft water head pressure.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.
B. Verify that mounting surfaces are ready to receive conduits.
C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.
B. Install conduit in accordance with NECA 1.
C. Galvanized Steel Rigid Metal Conduit (RMC): Install in accordance with NECA 101.
D. Intermediate Metal Conduit (IMC): Install in accordance with NECA 101.
E. Liquidtight Flexible Nonmetallic Conduit (LFNC): Install in accordance with NECA 111.
F. Conduit Routing:
    1. When conduit destination is indicated without specific routing, determine exact routing required.
    2. Conduits in the following areas may be exposed, unless otherwise indicated:
        a. Electrical rooms.
        b. Mechanical equipment rooms.
        c. Within joists in areas with no ceiling.
    3. Arrange conduit to maintain adequate headroom, clearances, and access.
    4. Arrange conduit to provide no more than equivalent of four 90-degree bends between pull points.
    5. Arrange conduit to provide no more than 150 feet between pull points.
    6. Route conduits above water and drain piping where possible.
    7. Arrange conduit to prevent moisture traps. Provide drain fittings at low points and at sealing fittings where moisture may collect.
    8. Maintain minimum clearance of 12 inches between conduits and hot surfaces. This includes, but is not limited to:
        a. Heaters.
        b. Hot water piping.
        c. Flues.

G. Conduit Support:
   1. Secure and support conduits in accordance with NFPA 70 using suitable supports and methods approved by authorities having jurisdiction; see Section 26-0529.
   2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.

H. Connections and Terminations:
   1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.
   2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.
   3. Use suitable adapters where required to transition from one type of conduit to another.
   4. Provide drip loops for liquidtight flexible conduit connections to prevent drainage of liquid into connectors.
   5. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.
   6. Provide insulating bushings, insulated throats, or listed metal fittings with smooth, rounded edges at conduit terminations to protect conductors.
   7. Secure joints and connections to provide mechanical strength and electrical continuity.

I. Penetrations:
   1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
   2. Make penetrations perpendicular to surfaces unless otherwise indicated.
   3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
   4. Conceal bends for conduit risers emerging above ground.
   5. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
   6. Install firestopping to preserve fire resistance rating of partitions and other elements.

J. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed conductors or connected equipment. This includes, but is not limited to:
   1. Where conduits cross structural joints intended for expansion, contraction, or deflection.
   2. Where conduits are subject to earth movement by settlement or frost.

K. Conduit Sealing:
   1. Use foam conduit sealant to prevent entry of moisture and gases. This includes, but is not limited to:
      a. Where conduits enter building from outside.
      b. Where service conduits enter building from underground distribution system.
      c. Where conduits enter building from underground.

d. Where conduits may transport moisture to contact live parts.

2. Where conduits cross barriers between areas of potential substantial temperature differential, use foam conduit sealant at accessible point near penetration to prevent condensation. This includes, but is not limited to:
   a. Where conduits pass from outdoors into conditioned interior spaces.
   b. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.

L. Provide grounding and bonding.

3.03 FIELD QUALITY CONTROL

A. See Section 01-4000 - QUALITY REQUIREMENTS for additional requirements.

B. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

C. Correct deficiencies and replace damaged or defective conduits.

3.04 CLEANING

A. Clean interior of conduits to remove moisture and foreign matter.

3.05 PROTECTION

A. Immediately after installation of conduit, use suitable manufactured plugs to provide protection from entry of moisture and foreign material and do not remove until ready for installation of conductors.

END OF SECTION 26-0533.13

SECTION 26-0533.16 - BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Outlet and device boxes up to 100 cubic inches, including those used as junction and pull boxes.

B. Cabinets and enclosures, including junction and pull boxes larger than 100 cubic inches.

C. Accessories.

1.02 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Coordinate minimum sizes of boxes with the actual installed arrangement of conductors, clamps, support fittings, and devices, calculated according to NFPA 70.
4. Coordinate minimum sizes of pull boxes with the actual installed arrangement of connected conduits, calculated according to NFPA 70.
5. Coordinate the placement of boxes with millwork, furniture, devices, equipment, etc. installed under other sections or by others.
6. Coordinate the work with other trades to preserve insulation integrity.
7. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted boxes where indicated.
8. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.03 SUBMITTALS

A. See Section 01-3000 - ADMINISTRATIVE REQUIREMENTS, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for cabinets and enclosures, boxes for hazardous (classified) locations, floor boxes, and underground boxes/enclosures.

C. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. See Section 01-6000 - PRODUCT REQUIREMENTS, for additional provisions.

1.04 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 BOXES

A. General Requirements:
   1. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.
   2. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.
   3. Provide products listed, classified, and labeled as suitable for the purpose intended.
   4. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
   5. Provide grounding terminals within boxes where equipment grounding conductors terminate.

B. Outlet and Device Boxes Up to 100 cubic inches, Including Those Used as Junction and Pull Boxes:
   1. Use sheet-steel boxes for dry locations unless otherwise indicated or required.
   2. Use cast iron boxes or cast aluminum boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.
   3. Use suitable concrete type boxes where flush-mounted in concrete.
   4. Use suitable masonry type boxes where flush-mounted in masonry walls.
   5. Use raised covers suitable for the type of wall construction and device configuration where required.
   6. Use shallow boxes where required by the type of wall construction.
   7. Do not use "through-wall" boxes designed for access from both sides of wall.
   8. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
   9. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.
   10. Boxes for Supporting Luminaires and Ceiling Fans: Listed as suitable for the type and weight of load to be supported; furnished with fixture stud to accommodate mounting of luminaire where required.
   11. Boxes for Ganged Devices: Use multigang boxes of single-piece construction. Do not use field-connected gangable boxes unless specifically indicated or permitted.

C. Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches:
   1. Comply with NEMA EN 10250, and list and label as complying with UL 50 and UL 50E, or UL 508A.
   2. NEMA EN 10250 Environment Type, Unless Otherwise Indicated:
   3. Junction and Pull Boxes Larger Than 100 cubic inches:
      a. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.

2.02 ACCESSORIES

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.
B. Verify that mounting surfaces are ready to receive boxes.
C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.
B. Install boxes in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards where mounting heights are not indicated.
C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
D. Box Supports:
    1. Secure and support boxes in accordance with NFPA 70 and Section 26-0529 using suitable supports and methods approved by the authority having jurisdiction.
    2. Provide independent support from building structure except for cast metal boxes (other than boxes used for fixture support) supported by threaded conduit connections in accordance with NFPA 70. Do not provide support from piping, ductwork, or other systems.
E. Install boxes plumb and level.
F. Flush-Mounted Boxes:
    1. Install boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that front edge of box or associated raised cover is not set back from finished surface more than 1/4 inch or does not project beyond finished surface.
    2. Install boxes in combustible materials such as wood so that front edge of box or associated raised cover is flush with finished surface.
    3. Repair rough openings around boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that there are no gaps or open spaces greater than 1/8 inch at the edge of the box.
G. Install boxes as required to preserve insulation integrity.
H. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
I. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07-8400.
J. Close unused box openings.
K. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.
L. Provide grounding and bonding in accordance with Section 26-0526.

3.03 CLEANING

A. Clean interior of boxes to remove dirt, debris, plaster and other foreign material.

3.04 PROTECTION

A. Immediately after installation, protect boxes from entry of moisture and foreign material until ready for installation of conductors.

END OF SECTION 26-0533.16

SECTION 26-0553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Electrical identification requirements.

B. Identification nameplates and labels.

C. Warning signs and labels.

1.02 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Verify final designations for equipment, systems, and components to be identified prior to fabrication of identification products.

B. Sequencing:

1. Do not conceal items to be identified, in locations such as above suspended ceilings, until identification products have been installed.
2. Do not install identification products until final surface finishes and painting are complete.

1.03 SUBMITTALS

A. See Section 01-3000 - ADMINISTRATIVE REQUIREMENTS for submittals procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product.

1.04 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.05 FIELD CONDITIONS

A. Do not install adhesive products when ambient temperature is lower than recommended by manufacturer.

PART 2 PRODUCTS

2.01 IDENTIFICATION REQUIREMENTS

A. Identification for Equipment:

1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.
    a. Enclosed switches, circuit breakers, and motor controllers:
        1) Identify voltage and phase.
        2) Identify power source and circuit number. Include location when not within sight of equipment.
        3) Identify load(s) served. Include location when not within sight of equipment.
2. Use identification nameplate to identify disconnect location for equipment with remote disconnecting means.
3. Use identification label or handwritten text using indelible marker on inside of door at each fused switch to identify required NEMA fuse class and size.

B. Identification for Conductors and Cables:

1. Color Coding for Power Conductors 600 V and Less: Comply with Section 26-0519.

2.02 IDENTIFICATION NAMEPLATES AND LABELS

A. Identification Nameplates:
   1. Materials:
      a. Indoor Clean, Dry Locations: Use plastic nameplates.
      b. Outdoor Locations: Use plastic, stainless steel, or aluminum nameplates suitable for exterior use.
   2. Plastic Nameplates: Two-layer or three-layer laminated acrylic or electrically non-conductive phenolic with beveled edges; minimum thickness of 1/16 inch; engraved text.
   3. Stainless Steel Nameplates: Minimum thickness of 1/32 inch; engraved or laser-etched text.
   4. Aluminum Nameplates: Anodized; minimum thickness of 1/32 inch; engraved or laser-etched text.
   5. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch high; Four, located at corners for larger sizes.

B. Identification Labels:
   1. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.
   2. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.

C. Format for Equipment Identification:
   1. Minimum Size: 1 inch by 2.5 inches.
   2. Legend:
      a. Equipment designation or other approved description.
   3. Text: All capitalized unless otherwise indicated.
   4. Minimum Text Height:
      a. Equipment Designation: 1/2 inch.
   5. Color:
      a. Normal Power System: White text on black background.
      b. Emergency Power System: White text on red background.

2.03 WARNING SIGNS AND LABELS

A. Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.

B. Warning Signs:
   1. Materials:
   2. Minimum Size: 7 by 10 inches unless otherwise indicated.

C. Warning Labels:
   1. Materials: Use factory pre-printed or machine-printed self-adhesive polyester or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969.

2. Machine-Printed Labels: Use thermal transfer process printing machines and accessories recommended by label manufacturer.
3. Minimum Size: 2 by 4 inches unless otherwise indicated.

PART 3 EXECUTION

3.01 PREPARATION

A. Clean surfaces to receive adhesive products according to manufacturer's instructions.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.
B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:
   1. Surface-Mounted Equipment: Enclosure front.
   2. Flush-Mounted Equipment: Inside of equipment door.
   3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
   4. Elevated Equipment: Legible from the floor or working platform.
   5. Interior Components: Legible from the point of access.
   6. Conductors and Cables: Legible from the point of access.
C. Install identification products centered, level, and parallel with lines of item being identified.
D. Secure nameplates to exterior surfaces of enclosures using stainless steel screws and to interior surfaces using self-adhesive backing or epoxy cement.
E. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.
F. Mark all handwritten text, where permitted, to be neat and legible.

3.03 FIELD QUALITY CONTROL

A. See Section 01-4000 - QUALITY REQUIREMENTS, for additional requirements.
B. Replace self-adhesive labels and markers that exhibit bubbles, wrinkles, curling or other signs of improper adhesion.

END OF SECTION 26-0553

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SECTION 26-2813 - FUSES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Fuses.

1.02 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate fuse clips furnished in equipment provided under other sections for compatibility with indicated fuses.
2. Coordinate fuse requirements according to manufacturer's recommendations and nameplate data for actual equipment to be installed.
3. Notify Engine of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.03 SUBMITTALS

A. See Section 01-3000 - ADMINISTRATIVE REQUIREMENTS, for submittal procedures.

B. Product Data: Provide manufacturer's standard data sheets including voltage and current ratings, interrupting ratings, time-current curves, and current limitation curves.

C. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. See Section 01-6000 - PRODUCT REQUIREMENTS, for additional provisions.

1.04 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Bussmann, a division of Eaton Corporation: www.cooperindustries.com/#sle.

B. Littelfuse, Inc: www.littelfuse.com/#sle.

C. Mersen: ep-us.mersen.com/#sle.

D. Substitutions: See Section 01-6000 - PRODUCT REQUIREMENTS.

2.02 APPLICATIONS

A. Individual Motor Branch Circuits: Class RK1, time-delay.

2.03 FUSES

A. Provide products listed, classified, and labeled as suitable for the purpose intended.

B. Unless specifically indicated to be excluded, provide fuses for all fusible equipment as required for a complete operating system.

C. Provide fuses of the same type, rating, and manufacturer within the same switch.

D. Comply with UL 248-1.

E. Unless otherwise indicated, provide cartridge type fuses complying with NEMA FU 1, Class and ratings as indicated.

F. Voltage Rating: Suitable for circuit voltage.

G. Class R Fuses: Comply with UL 248-12.

1. Class RK1, Time-Delay Fuses:
2. Class RK1, Fast-Acting, Non-Time-Delay Fuses:

H. Provide the following accessories where indicated or where required to complete installation:
1. Fuseholders: Compatible with indicated fuses.
2. Fuse Reducers: For adapting indicated fuses to permit installation in switch designed for fuses with larger ampere ratings.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that fuse ratings are consistent with circuit voltage and manufacturer's recommendations and nameplate data for equipment.

B. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Do not install fuses until circuits are ready to be energized.

B. Install fuses with label oriented such that manufacturer, type, and size are easily read.

END OF SECTION 26-2813

SECTION 26-2913 - ENCLOSED CONTROLLERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Enclosed NEMA controllers for low-voltage (600 V and less) applications:
   1. Magnetic motor starters.
B. Overcurrent protective devices for motor controllers, including overload relays.
C. Control accessories:
   1. Auxiliary contacts.
   2. Pilot devices.
   3. Control and timing relays.
   4. Control power transformers.

1.02 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances required by NFPA 70.
   2. Coordinate the work to provide motor controllers and associated overload relays suitable for use with the actual motors to be installed.
   3. Coordinate the work to provide controllers and associated wiring suitable for interface with control devices to be installed.
   4. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
   5. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
   6. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.03 SUBMITTALS

A. See Section 01-3000 - ADMINISTRATIVE REQUIREMENTS, for submittal procedures.
B. Product Data: Provide manufacturer's standard catalog pages and data sheets for motor controllers, enclosures, overcurrent protective devices, and other installed components and accessories.
C. Shop Drawings: Indicate dimensions, voltage, controller sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01-6000 - PRODUCT REQUIREMENTS, for additional provisions.

1.04 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to internal components, enclosure, and finish.

1.06 FIELD CONDITIONS

A. Maintain field conditions within required service conditions during and after installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. ABB/GE: www.electrification.us.abb.com/#sle.

B. Eaton Corporation: www.eaton.com/#sle.

C. Rockwell Automation, Inc; Allen-Bradley Products: ab.rockwellautomation.com/#sle.

D. Schneider Electric; Square D Products: www.schneider-electric.us/#sle.

E. Siemens Industry, Inc: www.usa.siemens.com/#sle.

F. Substitutions: See Section 01-6000 - PRODUCT REQUIREMENTS.

2.02 ENCLOSED CONTROLLERS

A. Provide enclosed controller assemblies consisting of all required components, control power transformers, instrumentation and control wiring, accessories, etc. as necessary for a complete operating system.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Description: Enclosed controllers complying with NEMA ICS 2, and listed and labeled as complying with UL 60947-1 and UL 60947-4-1; ratings, configurations and features as indicated on the drawings.

D. Service Conditions:

1. Provide controllers and associated components suitable for operation under the following service conditions without derating:
    a. Altitude:
        1) Class 1 Km Equipment (devices utilizing power semiconductors, e.g. variable frequency controllers): Less than 3,300 feet.
        2) Class 2 Km Equipment (electromagnetic and manual devices): Less than 6,600 feet.
    b. Ambient Temperature: Between 32 degrees F and 104 degrees F.
2. Provide controllers and associated components suitable for operation at indicated ratings under the service conditions at the installed location.

E. Conductor Terminations: Suitable for use with the conductors to be installed.

F. Enclosures:

1. Comply with NEMA IA 10030.
2. Environment Type per NEMA EN 10250: Unless otherwise indicated, as specified for the following installation locations:
3. Finish: Manufacturer's standard unless otherwise indicated.

G. Magnetic Motor Starters: Combination type unless otherwise indicated.
   1. Combination Magnetic Motor Starters: NEMA ICS 2, Class A combination motor controllers with magnetic contactor(s), externally operable disconnect and overload relay(s).
   2. Noncombination Magnetic Motor Starters: NEMA ICS 2, Class A noncombination motor controllers with magnetic contactor(s) and overload relay(s).
   3. Configuration: Full-voltage non-reversing unless otherwise indicated.
   4. Minimum Starter Size: NEMA Size 0.
   5. Disconnects: Disconnect switch type.
      a. Disconnect Switches: Fusible type unless otherwise indicated.
      b. Provide externally operable handle with means for locking in the OFF position. Provide safety interlock to prevent opening the cover with the disconnect in the ON position with capability of overriding interlock for testing purposes.
      c. Provide auxiliary interlock for disconnection of external control power sources where applicable.
   6. Overload Relays: Bimetallic thermal type unless otherwise indicated.
   7. Pilot Devices Required:
      a. Furnish local pilot devices for each unit as specified below unless otherwise indicated on drawings.
      b. Single-Speed, Non-Reversing Starters:

2.03 OVERCURRENT PROTECTIVE DEVICES

A. Overload Relays:
   1. Provide overload relays and, where applicable, associated current elements/heaters, selected according to actual installed motor nameplate data, in accordance with manufacturer's recommendations and NFPA 70; include consideration for motor service factor and ambient temperature correction, where applicable.
   2. Inverse-Time Trip Class Rating: Class 20 unless otherwise indicated or required.
   3. Trip-free operation.
   4. Visible trip indication.
   5. Resettable.
      a. Employ manual reset unless otherwise indicated.
      b. Do not employ automatic reset with two-wire control.
   6. Bimetallic Thermal Overload Relays:
      a. Interchangeable current elements/heaters.
      b. Adjustable trip; plus/minus 10 percent of nominal, minimum.
      c. Trip test function.

B. Fusible Disconnect Switches:

1. Description: Quick-make, quick-break, dead-front fusible switch units complying with NEMA BS 31047, and listed and labeled as complying with UL 98; ratings, configurations, and features as indicated on the drawings.
2. Fuse Clips: As required to accept indicated fuses.
3. Provide externally operable handle with means for locking in the OFF position. Provide means for locking switch cover in the closed position. Provide safety interlock to prevent opening the cover with the switch in the ON position with capability of overriding interlock for testing purposes.

2.04 CONTROL ACCESSORIES

A. Auxiliary Contacts:
   1. Comply with NEMA IA 10039.
   2. Provide number and type of contacts indicated or required to perform necessary functions, including holding (seal-in) circuit and interlocking, plus one normally open (NO) and one normally closed (NC) spare contact for each magnetic motor starter, minimum.

B. Pilot Devices:
   1. Comply with NEMA IA 10039; heavy-duty type.
   2. Pushbuttons: Unless otherwise indicated, provide momentary, non-illuminated type with flush button operator; normally open or normally closed as indicated or as required.
   3. Selector Switches: Unless otherwise indicated, provide maintained, non-illuminated type with knob operator; number of switch positions as indicated or as required.
   4. Indicating Lights: Push-to-test type unless otherwise indicated.
   5. Provide LED lamp source for indicating lights and illuminated devices.

C. Control and Timing Relays:
   1. Comply with NEMA IA 10039.
   2. Provide number and type of relays indicated or required to perform necessary functions.

D. Control Power Transformers:
   1. Size to accommodate burden of contactor coil(s) and all connected auxiliary devices.
   2. Include primary and secondary fuses.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.
B. Verify that ratings of enclosed controllers are consistent with the indicated requirements.
C. Verify that mounting surfaces are ready to receive enclosed controllers.
D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.
B. Install controllers in accordance with NECA 1 (general workmanship).
C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

D. Provide required support and attachment in accordance with Section 26-0529.
E. Install enclosed controllers plumb and level.
F. Provide grounding and bonding in accordance with Section 26-0526.
G. Install all field-installed devices, components, and accessories.
H. Provide fuses complying with Section 26-2813 for fusible switches as indicated.
I. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.
J. Set field-adjustable controllers and associated components according to installed motor requirements, in accordance with manufacturer's recommendations and NFPA 70.

3.03 FIELD QUALITY CONTROL

A. See Section 01-4000 - QUALITY REQUIREMENTS, for additional requirements.
B. Inspect and test in accordance with NETA ATS, except Section 4.
C. Motor Starters: Perform inspections and tests listed in NETA ATS, Section 7.16.1.1. Tests listed as optional are not required.
D. Fusible Switches: Perform inspections and tests listed in NETA ATS, Section 7.5.1.1.
E. Correct deficiencies and replace damaged or defective enclosed controllers or associated components.

3.04 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.05 CLEANING

A. Clean dirt and debris from controller enclosures and components according to manufacturer's instructions.
B. Repair scratched or marred exterior surfaces to match original factory finish.

3.06 CLOSEOUT ACTIVITIES

A. See Section 01-7800 - CLOSEOUT SUBMITTALS, for closeout submittals.

3.07 PROTECTION

A. Protect installed enclosed controllers from subsequent construction operations.

END OF SECTION 26-2913