

# VOLUME II - PROJECT MANUAL

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## **Northwoods Park Middle School Gymnasium & Renovation**

904 Sioux Dr.  
Jacksonville, North Carolina 28540

Onslow County Schools

SMITH SINNETT ARCHITECTURE

PROJECT NO. 2022035.00

DATE: 17 JANUARY 2024

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**SECTION 21 05 00**  
**COMMON WORK RESULTS FOR FIRE SUPPRESSION**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A Pipe, fittings, sleeves, escutcheons, seals, and connections for sprinkler systems.
- B Expansion joints
- C Expansion loops
- D Grout
- E Fire-Suppression equipment and piping demolition where applicable
- F Equipment Installation
- G Painting and Finishing
- H Concrete Bases
- I Supports and Anchorage

**1.02 REFERENCE STANDARDS**

- A ASME A112.18.1 - Plumbing Supply Fittings; 2018, with Errata.
- B ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators; 2023.
- C ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250; 2020.
- D ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; 2021.
- E ASME B16.4 - Gray Iron Threaded Fittings: Classes 125 and 250; 2021.
- F ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard; 2020.
- G ASME B16.9 - Factory-Made Wrought Buttwelding Fittings; 2018.
- H ASME B16.11 - Forged Fittings, Socket-Welding and Threaded; 2021.
- I ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2021.
- J ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2021.
- K ASME B16.25 - Buttwelding Ends; 2022.
- L ASME B36.10M - Welded and Seamless Wrought Steel Pipe; 2022.
- M ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings; 1999, with Editorial Revision (2022).
- N ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2022.
- O ASTM A135/A135M - Standard Specification for Electric-Resistance-Welded Steel Pipe; 2021.
- P ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2023.
- Q ASTM A269/A269M - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service; 2022.
- R ASTM A536 - Standard Specification for Ductile Iron Castings; 1984, with Editorial Revision (2019).
- S ASTM A795/A795M - Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use; 2021.
- T ASTM B32 - Standard Specification for Solder Metal; 2020.
- U ASTM B75/B75M - Standard Specification for Seamless Copper Tube; 2020.
- V ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2022.
- W ASTM C592 - Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type); 2022a.
- X ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2018b.
- Y ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems; 2013a (Reapproved 2017).
- Z AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding; 2019.
- AA AWS D1.1/D1.1M - Structural Welding Code - Steel; 2020, with Errata (2022).
- BB AWWA C110/A21.10 - Ductile-Iron and Gray-Iron Fittings; 2021.
- CC AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings; 2017.
- DD AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast; 2017, with Errata (2018).

- EE AWWA C606 - Grooved and Shouldered Joints; 2022.
- FF FM (AG) - FM Approval Guide; Current Edition.
- GG ITS (DIR) - Directory of Listed Products; current edition.
- HH NFPA 13 - Standard for the Installation of Sprinkler Systems; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- II UL (DIR) - Online Certifications Directory; Current Edition.

**1.03 SUBMITTALS**

- A Refer to Division 01 Specifications for Submittal Procedures.
- B Refer to Specification Section 21 13 00 FIRE SUPPRESSION SPRINKLER SYSTEMS for full Submittal Requirements.

**1.04 QUALITY ASSURANCE**

- A Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- B Installer Qualifications: Company specializing in performing work of the type specified in this section.
  - 1. Minimum five years experience.
- C Comply with FM (AG), UL (DIR), and ITS (DIR) or Warnock Hersey requirements.
- D Valves: Bear FM (AG), UL (DIR), and ITS (DIR) or Warnock Hersey product listing label or marking. Provide manufacturer's name and pressure rating marked on valve body.
- E Products Requiring Electrical Connection: Listed and classified as suitable for the purpose specified and indicated.
- F Clean equipment, pipes, valves, and fittings of grease, metal cuttings, and sludge that may have accumulated from the installation and testing of the system.

**1.05 DELIVERY, STORAGE, AND HANDLING**

- A Deliver and store valves in shipping containers, with labeling in place.
- 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.

**1.06 WARRANTY**

- A Correct defective Work within a five year period after Date of Substantial Completion.

**PART 2 PRODUCTS**

**2.01 FIRE PROTECTION SYSTEMS**

- A Sprinkler Systems: Comply with NFPA 13.
- B Welding Materials and Procedures: Comply with ASME BPVC-IX.

**2.02 ABOVE GROUND PIPING**

- A Steel Pipe: ASTM A53 Schedule 40 or ASTM A795 Schedule 40, black.
  - 1. Steel Fittings: ASME B16.5 steel flanges and fittings.
  - 2. Cast Iron Fittings: ASME B16.1, flanges and flanged fittings and ASME B16.4, threaded fittings.
  - 3. Malleable Iron Fittings: ASME B16.3, threaded fittings and ASTM A47/A47M.
  - 4. Mechanical Grooved Couplings: Malleable iron housing clamps to engage and lock, "C" shaped elastomeric sealing gasket, steel bolts, nuts, and washers; galvanized for galvanized pipe.
  - 5. Mechanical Formed Fittings: Carbon steel housing with integral pipe stop and O-ring pocked and O-ring, uniformly compressed into permanent mechanical engagement onto pipe.

**2.03 PIPE SLEEVES**

- A Vertical Piping:
  - 1. Sleeve Length: 1 inch above finished floor.
  - 2. Provide sealant for watertight joint.
  - 3. Blocked Out Floor Openings: Provide 1-1/2 inch angle set in silicon adhesive around opening.
  - 4. Drilled Penetrations: Provide 1-1/2 inch angle ring or square set in silicone adhesive around penetration.
- B Plastic, Sheet Metal, or Moisture-Resistant Fiber: Pipe passing through interior walls, partitions, and floors, unless steel or brass sleeves are specified below.
- C Pipe Passing Through Below Grade Exterior Walls:
  - 1. Zinc-coated or cast-iron pipe.

2. Provide watertight space with link rubber or modular seal between sleeve and pipe on both pipe ends.
- D Pipe Passing Through Quarry Tile, Terrazzo, or Ceramic Tile Floors:
  1. Brass pipe.
  2. Connect sleeve with floor plate.
- E Pipe Passing Through Mechanical, Laundry, and Animal Room Floors above Basement:
  1. Galvanized steel pipe or black iron pipe with asphalt coating.
  2. Connect sleeve with floor plate except in mechanical rooms.
- F Clearances:
  1. Provide allowance for insulated piping.
  2. Wall, Floor, Floor, Partitions, and Beam Flanges: 1 inch greater than external; pipe diameter.

#### 2.04 MANUFACTURED SLEEVE-SEAL SYSTEMS

- A Manufacturers:
  1. The Metraflex Company
  2. or approved equal.
- B Modular/Mechanical Seal:
  1. Synthetic rubber interlocking links continuously fill annular space between pipe and wall/casing opening.
  2. Provide watertight seal between pipe and wall/casing opening.
  3. Elastomer element size and material in accordance with manufacturer's recommendations.
  4. Glass-reinforced plastic pressure endplates.

#### 2.05 ESCUTCHEONS

- A Manufacturers:
  1. Fire Protection Products, Inc: [www.fppi.com.com](http://www.fppi.com.com).
  2. Tyco Fire Protection Products: [www.tyco-fire.com](http://www.tyco-fire.com).
  3. Viking Group Inc: [www.vikinggroupinc.com](http://www.vikinggroupinc.com).
  4. Victaulic Firelock.
- B Material:
  1. Fabricate from nonferrous metal.
  2. Chrome-plated.
  3. Metals and Finish: Comply with ASME A112.18.1.
- C Construction:
  1. One-piece for mounting on chrome-plated tubing or pipe and one-piece type elsewhere.
  2. Internal spring tension devices or setscrews to maintain a fixed position against a surface.

#### 2.06 PIPE HANGERS AND SUPPORTS

- A Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron, adjustable swivel, split ring.
- B Hangers for Pipe Sizes 2 inches and Over: Carbon steel, adjustable, clevis.
- C Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
- D Wall Support for Pipe Sizes to 3 inches: Cast iron hook.
- E Wall Support for Pipe Sizes 4 inches and Over: Welded steel bracket and wrought steel clamp.
- F Vertical Support: Steel riser clamp.
- G Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

#### 2.07 EXPANSION LOOPS - HOSE AND BRAID

- A Manufacturers:
  1. The Metraflex Company; FireLoop: [www.metrafire.com/#sle](http://www.metrafire.com/#sle).
  2. or approved equal.
- B Provide flexible loops with two flexible sections of hose and braid, two 90-degree elbows, and 180-degree return with support bracket and air release or drain plug.
- C Provide flexible loops capable of movement in the x, y, and z planes. Flexible loops to impart no thrust loads to the building structure.
- D Flexible Connectors: Flanged, braided type with wetted components of stainless steel, sized to match piping.
  1. Maximum Allowable Working Pressure: 150 psig at 120 degrees F.

2. End Connections: Same as specified for pipe jointing.
3. Provide necessary accessories including, but not limited to, swivel joints.

## **2.08 MECHANICAL COUPLINGS**

- A Manufacturers:
1. Tyco Fire Protection Products: [www.tyco-fire.com/#sle](http://www.tyco-fire.com/#sle).
  2. Victaulic Company; FireLock Style 009H: [www.victaulic.com/#sle](http://www.victaulic.com/#sle).
  3. Anvil/Gruvlock.
- B Rigid Mechanical Couplings for Grooved Joints:
1. Dimensions and Testing: Comply with AWWA C606.
  2. Minimum Working Pressure: 300 psig.
  3. Housing Material: Fabricate of ductile iron complying with ASTM A536.
  4. Housing Coating: Factory applied orange enamel.
  5. Gasket Material: EPDM suitable for operating temperature range from minus 30 degrees F to 230 degrees F.
  6. Bolts and Nuts: Hot-dipped-galvanized or zinc-electroplated steel.
  7. Provide stops for direct stab installation without field assembly.

## **PART 3 EXECUTION**

### **3.01 PREPARATION**

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

### **3.02 INSTALLATION**

- A Install sprinkler system and service main piping, hangers, and supports in accordance with NFPA 13.
- B Install standpipe piping, hangers, and supports in accordance with NFPA 14.
- C Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.
- D Install piping to conserve building space, to not interfere with use of space and other work.
- E Group piping whenever practical at common elevations.
- F Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- G Inserts:
1. Provide inserts for placement in concrete formwork.
  2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
  3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
  4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
  5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.
- H Pipe Hangers and Supports:
1. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
  2. Place hangers within 12 inches of each horizontal elbow.
  3. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
  4. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
  5. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
  6. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
- I Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.
- J Prepare pipe, fittings, supports, and accessories for finish painting. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc-rich primer to welding.
- K Structural Considerations:



1. Do not penetrate building structural members unless indicated.
2. Locate flexible expansion loops at or near the building seismic joint.
- L Provide sleeves when penetrating footings, floors, walls, and partitions. Seal pipe including sleeve penetrations to achieve fire resistance equivalent to fire separation required.
  1. Underground Piping: Caulk pipe sleeve watertight with lead and oakum or mechanically expandable chloroprene inserts with bitumen sealed metal components.
  2. Aboveground Piping:
    - a. Pack solid using mineral fiber complying with ASTM C592.
    - b. Fill space with an elastomer caulk to a depth of 0.50 inch where penetrations occur between conditioned and unconditioned spaces.
  3. All Rated Openings: Caulk tight with firestopping material complying with ASTM E814 in accordance with Section 07 84 00 to prevent the spread of fire, smoke, and gases.
  4. Caulk exterior wall sleeves watertight with lead and oakum or mechanically expandable chloroprene inserts with mastic-sealed components.
- M Manufactured Sleeve-Seal Systems:
  1. Install manufactured sleeve-seal systems in sleeves located in grade slabs and exterior concrete walls at piping entrances into building.
  2. Provide sealing elements of the size, quantity, and type required for the piping and sleeve inner diameter or penetration diameter.
  3. Locate piping in center of sleeve or penetration.
  4. Install field assembled sleeve-seal system components in annular space between sleeve and piping.
  5. Tighten bolting for a watertight seal.
  6. Install in accordance with manufacturer's recommendations.
- N Escutcheons:
  1. Install and firmly attach escutcheons at piping penetrations into finished spaces.
  2. Provide escutcheons on both sides of partitions separating finished areas through which piping passes.
  3. Attach plates at the underside only of suspended ceilings.
  4. Use chrome plated escutcheons in occupied spaces and to conceal openings in construction.
- O When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, unions, and couplings for servicing are consistently provided.
- P Die-cut threaded joints with full-cut, standard taper pipe threads with red lead and linseed oil or other non-toxic joint compound applied to male threads only.

### 3.03 CLEANING

- A Upon completion of work, clean all parts of the installation.
- B Clean equipment, pipes, valves, and fittings of grease, metal cuttings, and sludge that may have accumulated from the installation and testing of the system.
- C Spray-on Fireproofing overspray shall be removed from all piping, fittings, and all materials provided as part of the fire protection (sprinkler system) contract.

**END OF SECTION 21 05 00**

**SECTION 21 05 23**

**GENERAL-DUTY VALVES FOR WATER-BASED FIRE-SUPPRESSION PIPING**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A Two-piece ball valves with indicators.
- B Bronze butterfly valves with indicators.
- C Iron butterfly valves with indicators.
- D Check valves.
- E Bronze OS&Y gate valves.
- F Iron OS&Y gate valves.
- G NRS gate valves.
- H Indicator posts.
- I Trim and drain valves.

**1.02 RELATED REQUIREMENTS**

- A Section 21 05 00 - Common Work Results for Fire Suppression: Pipe and fittings.
- B Section 21 05 48 - Vibration and Seismic Controls for Fire Suppression Piping and Equipment.
- C Section 21 05 53 - Identification for Fire Suppression Piping and Equipment.
- D Section 21 07 19 - Fire Suppression Piping Insulation.
- E Section 21 12 00 - Fire-Suppression Standpipes.
- F Section 21 13 00 - Fire-Suppression Sprinkler Systems.

**1.03 ABBREVIATIONS AND ACRONYMS**

- A EPDM: Ethylene-propylene diene monomer.
- B NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
- C NRS: Non-rising stem.
- D OS&Y: Outside screw and yoke.
- E PTFE: Polytetrafluoroethylene.
- F SBR: Styrene-butadiene rubber.

**1.04 REFERENCE STANDARDS**

- A ASME B1.20.1 - Pipe Threads, General Purpose, Inch; 2013 (Reaffirmed 2018).
- B ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250; 2020.
- C ASME B31.9 - Building Services Piping; 2020.
- D ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators; 2023.
- E AWWA C508 - Swing-Check Valves for Waterworks Service, 2-In. Through 48-In. (50-mm Through 1,200-mm) NPS; 2017.
- F AWWA C606 - Grooved and Shouldered Joints; 2022.
- G FM (AG) - FM Approval Guide; Current Edition.
- H NFPA 13 - Standard for the Installation of Sprinkler Systems; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- I NFPA 13R - Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies; 2022, with Errata.
- J UL (DIR) - Online Certifications Directory; Current Edition.
- K UL 262 - Gate Valves for Fire-Protection Service; Current Edition, Including All Revisions.
- L UL 312 - Check Valves for Fire-Protection Service; Current Edition, Including All Revisions.
- M UL 789 - Indicator Posts for Fire-Protection Service; Current Edition, Including All Revisions.
- N UL 1091 - Standard for Butterfly Valves for Fire-Protection Service; Current Edition, Including All Revisions.

**1.05 ADMINISTRATIVE REQUIREMENTS**

- A Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.

## 1.06 SUBMITTALS

- A See Section 01 30 00 - 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 Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.
- D Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts listings.

## 1.07 QUALITY ASSURANCE

- A Manufacturer Qualifications:
  - 1. Obtain valves for each valve type from single manufacturer.
  - 2. Company must specialize in manufacturing products specified in this section, with not less than three years of documented experience.
- B Where listed products are specified, provide products listed, classified, and labeled by FM (AG), UL (DIR), or testing firm acceptable to authorities having jurisdiction as suitable for the purpose indicated.
- C Welding Materials and Procedures: Comply with ASME BPVC-IX.
- D Installer, Maintenance Contractor, and Testing Agency Qualifications:
  - 1. Company specializing in performing the work of this section with minimum five years documented experience.
  - 2. Trained and approved by manufacturer to design, install, test and maintain the equipment specified herein.
  - 3. Complies with manufacturer's certification requirements.
  - 4. Complies with manufacturer's insurance requirements.

## 1.08 DELIVERY, STORAGE, AND HANDLING

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

## PART 2 PRODUCTS

### 2.01 GENERAL REQUIREMENTS

- A UL Listed: Provide valves listed in UL (DIR) under following headings and bearing UL mark:
  - 1. Main Level: HAMV - Fire Main Equipment.
    - a. Level 1: HCBZ - Indicator Posts, Gate Valve.
    - b. Level 1: HLOT - Valves.
    - c. Level 3: HLUG - Ball Valves, System Control.
    - d. Level 3: HLXS - Butterfly Valves.
    - e. Level 3: HMER - Check Valves.
    - f. Level 3: HMRZ - Gate Valves.
  - 2. Main Level: VDGT - Sprinkler System & Water Spray System Devices.
    - a. Level 1: VQGU - Valves, Trim, and Drain.
- B FM Global Approved: Provide valves listed in FM (AG) Approval Guide under the following headings:

1. Automated Sprinkler Systems:
  - a. Indicator posts.
  - b. Valves:
    - 1) Gate valves.
    - 2) Single check valves.
    - 3) Miscellaneous valves.
- C ASME Compliance:
  1. ASME B16.1 for flanges on iron valves.
  2. ASME B1.20.1 for threads on threaded-end valves.
  3. ASME B31.9 for building services piping valves.
- D Comply with AWWA C606 for grooved-end connections.
- E Comply with NFPA 20, NFPA 13R, and \_\_\_\_ for valves.
- F Valve Pressure Ratings: Not less than minimum pressure rating indicated or higher as required.
- G Valve Sizes: Same as upstream piping unless otherwise indicated.
- H Valve Actuator Types:
  1. Worm-gear actuator with handwheel for quarter-turn valves, except trim and drain valves.
  2. Handwheel: For other than quarter-turn trim and drain valves.
  3. Hand-lever: For quarter-turn trim and drain valves 2 NPS and smaller.

## 2.02 TWO-PIECE BALL VALVES WITH INDICATORS

- A Manufacturers:
  1. Victaulic Co. of America
  2. Tyco
  3. Nibco
- B UL 1091, except with ball instead of disc and FM (AG) standard listing for indicating valves (butterfly or ball type), Class Number 1112.
- C Description:
  1. Minimum Pressure Rating: 175 psig.
  2. Body Design: Two piece.
  3. Body Material: Forged brass or bronze.
  4. Port Size: Full or standard.
  5. Seat: PTFE.
  6. Stem: Bronze or stainless steel.
  7. Ball: Chrome-plated brass.
  8. Actuator: Worm gear or traveling nut.
  9. Supervisory Switch: Internal or external.
  10. End Connections for Valves 1 NPS through 2 NPS: Threaded ends or Grooved where available.
  11. End Connections for Valves 2-1/2 NPS: Grooved ends.

## 2.03 BRONZE BUTTERFLY VALVES WITH INDICATORS

- A Manufacturers:
  1. Victaulic Co. of America.
  2. Tyco.
  3. Nibco
- B UL 1091 and FM (AG) standard listing for indicating valves, (butterfly or ball type), Class Number 1112.
- C Minimum Pressure Rating: 175 psig.
- D Body Material: Bronze.
- E Seat: EPDM.
- F Stem: Bronze or stainless steel.
- G Disc: Bronze with EPDM coating.
- H Actuator: Worm gear or traveling nut.
- I Supervisory Switch: Internal or external.
- J End Connections for Valves 1 NPS through 2 NPS: Threaded ends or Grooved where available.

K End Connections for Valves 2-1/2 NPS: Grooved ends.

**2.04 IRON BUTTERFLY VALVES WITH INDICATORS**

A Manufacturers:

1. Victaulic Co. of America.
2. Nibco
3. Tyco

B UL 1091 and FM (AG) standard listing for indicating valves (butterfly or ball type), Class Number 112.

C Minimum Pressure Rating: 175 psig.

D Body Material: Cast or ductile iron with nylon, EPDM, epoxy, polyamide, or approved coating.

E Seat: EPDM.

F Stem: Stainless steel.

G Disc: Ductile iron, nickel plated.

H Actuator: Worm gear or traveling nut.

I Supervisory Switch: Internal or external.

J Body Design: Grooved-end connections.

**2.05 CHECK VALVES**

A Manufacturers:

1. Victaulic Co. of America.
2. Nibco
3. Tyco

B UL 312 and FM (AG) standard listing for check valves, Class Number 1045.

C Minimum Pressure Rating: 175 psig.

D Type: Center guided check valve.

E Body Material: Cast iron, ductile iron.

F Center guided check with elastomeric seal.

G Hinge Spring: Stainless steel.

H End Connections: Flanged, grooved, or threaded.

**2.06 BRONZE OS&Y GATE VALVES**

A Manufacturers:

1. Victaulic Co. of America.
2. Tyco.
3. Nibco

B UL 262 and FM (AG) standard listing for fire-service water control valves (OS&Y and NRS-type gate valves).

C Minimum Pressure Rating: 175 psig.

D Body and Bonnet Material: Bronze or brass.

E Wedge: One-piece bronze or brass.

F Wedge Seat: Bronze.

G Stem: Bronze or brass.

H Packing: Non-asbestos PTFE.

I Supervisory Switch: External.

J End Connections: Threaded.

**2.07 IRON OS&Y GATE VALVES**

A Manufacturers:

1. Victaulic Co. of America.
2. Nibco
3. Tyco

B UL 262 and FM (AG) standard listing for fire-service water control valves (OS&Y and NRS-type gate valves).

C Minimum Pressure Rating: 175 psig.

D Body and Bonnet Material: Cast or ductile iron.

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- E Wedge: Cast or ductile iron, or bronze with elastomeric coating.
- F Wedge Seat: Cast or ductile iron, or bronze with elastomeric coating.
- G Stem: Brass or bronze.
- H Packing: Non-asbestos PTFE.
- I Supervisory Switch: External.
- J End Connections: Flanged.

**2.08 NRS GATE VALVES**

- A Manufacturers:
  - 1. Victaulic Co. of America.
  - 2. Tyco.
  - 3. Nibco
- B UL 262 and FM (AG) standard listing for fire-service water control valves (OS&Y and NRS-type gate valves).
- C Minimum Pressure Rating: 175 psig.
- D Body and Bonnet Material: Cast or ductile iron.
- E Wedge: Cast or ductile iron with elastomeric coating.
- F Wedge Seat: Cast or ductile iron, or bronze with elastomeric coating.
- G Stem: Brass or bronze.
- H Packing: Non-asbestos PTFE.
- I Supervisory Switch: External.
- J End Connections: Flanged.

**2.09 INDICATOR POSTS**

- A Manufacturers:
  - 1. Victaulic Co. of America.
  - 2. Tyco.
  - 3. Nibco
  - 4. Viking
- B UL 789 and FM (AG) standard listing for indicator posts.
- C Type: Underground.
- D Base Barrel Material: Cast or ductile iron.
- E Extension Barrel for Adjustable Length Indicator Posts: Cast or ductile iron.
- F Cap: Cast or ductile iron.
- G Operation: Wrench.

**2.10 TRIM AND DRAIN VALVES**

- A Ball Valves:
  - 1. Manufacturers:
    - a. Victaulic Co. of America.
    - b. Tyco.
    - c. Viking.
    - d. Nibco
  - 2. Description:
    - a. Pressure Rating: 175 psig.
    - b. Body Design: Two piece.
    - c. Body Material: Forged brass or bronze.
    - d. Port Size: Full or standard.
    - e. Seat: PTFE.
    - f. Stem: Bronze or stainless steel.
    - g. Ball: Chrome-plated brass.
    - h. Actuator: Hand-lever.
    - i. End Connections for Valves 1 NPS through 2-1/2 NPS: Threaded ends or Grooved where available.

- j. End Connections for Valves 1-1/4 NPS and 2-1/2 NPS: Grooved ends.
- B Angle Valves:
  - 1. Manufacturers:
    - a. Victaulic Co. of America.
    - b. Tyco.
    - c. Viking.
    - d. Nibco
  - 2. Description:
    - a. Pressure Rating: 175 psig.
    - b. Body Material: Brass or bronze.
    - c. Ends: Threaded.
    - d. Stem: Bronze.
    - e. Disc: Bronze.
    - f. Packing: Asbestos free.
    - g. Handwheel: Malleable iron, bronze, or aluminum.
- C Globe Valves:
  - 1. Manufacturers:
    - a. Victaulic Co. of America.
    - b. Tyco.
    - c. Viking.
    - d. Nibco
  - 2. Description:
    - a. Pressure Rating: 175 psig.
    - b. Body Material: Bronze with integral seat and screw-in bonnet.
    - c. Ends: Threaded.
    - d. Stem: Bronze.
    - e. Disc Holder and Nut: Bronze.
    - f. Disc Seat: Nitrile.
    - g. Packing: Asbestos free.
    - h. Handwheel: Malleable iron, bronze, or aluminum.

### **PART 3 EXECUTION**

#### **3.01 EXAMINATION**

- A Confirm valve interior to be free of foreign matter and corrosion.
- B Remove packing materials.
- C Examine guides and seats by operating valves from the fully open position to the fully closed position.
- D Examine valve threads and mating pipe for form and cleanliness.
- E Examine mating flange faces for conditions that might cause leakage.
  - 1. Check bolting for proper size, length, and material.
  - 2. Verify gasket for size, defects, damage, and suitable material composition for service.
  - 3. Replace all defective valves with new valves.

#### **3.02 INSTALLATION**

- A Comply with specific valve installation requirements and application in the following Sections:
  - 1. Section 21 12 00 for application of valves in fire-suppression standpipes.
  - 2. Section 21 13 00 for application of valves in wet and dry pipe, fire-suppression sprinkler systems.
  - 3. Section 21 13 39 for application of valves in foam-water, fire-suppression sprinkler systems.
- B Install listed fire protection shutoff valves supervised-open, located to control sources of water supply except from fire department connections.
  - 1. Install permanent identification signs indicating portion of system controlled by each valve.
- C Install check valve in water supply connections and backflow preventer at potable water supply connections.
- D Valves with threaded connections to have unions at equipment arranged for easy access, service, maintenance, and equipment removal without system shutdown.

- E Valves in horizontal piping installed with stem at or above the pipe center.
- F Position valves to allow full stem movement.
- G Install valve tags. Comply with Section 21 05 53 requirements for valve tags, schedules, and signs on surfaces concealing valves; and the appropriate NFPA standard applying to the piping system in which valves are installed.

**END OF SECTION 21 05 23**



**SECTION 21 05 53**

**IDENTIFICATION FOR FIRE SUPPRESSION PIPING AND EQUIPMENT**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

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

**1.02 REFERENCE STANDARDS**

- A ASME A13.1 - Scheme for the Identification of Piping Systems; 2020.
- B ASTM D709 - Standard Specification for Laminated Thermosetting Materials; 2017.

**1.03 SUBMITTALS**

- A List: Submit list of wording, symbols, letter size, and color coding for mechanical identification.
- B Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
- C Product Data: Provide manufacturers catalog literature for each product required.
- D Project Record Documents: Record actual locations of tagged valves.

**PART 2 PRODUCTS**

**2.01 IDENTIFICATION APPLICATIONS**

- A Automatic Controls: Tags.
- B Control Panels: Nameplates.
- C Instrumentation: Tags.
- D Major Control Components: Nameplates.
- E Piping: Tags.
- F Pumps: Nameplates.
- G Relays: Tags.
- H Small-sized Equipment: Tags.
- I Thermostats: Nameplates.
- J Valves: Nameplates and ceiling tacks where above lay-in ceilings. Note: Identification Signs shall be provided at each valve to indicate its function and what it controls. (NFPA 13:8.16.1.1.8)

**2.02 NAMEPLATES**

- A Manufacturers:
  - 1. Brimar Industries, Inc: [www.pipemarker.com/#sle](http://www.pipemarker.com/#sle).
  - 2. Kolbi Pipe Marker Company: [www.kolbipipemarkers.com/#sle](http://www.kolbipipemarkers.com/#sle).
  - 3. Seton Identification Products, a Tricor Direct Company: [www.seton.com/#sle](http://www.seton.com/#sle).
- B Description: Laminated three-layer plastic with engraved letters.
  - 1. Letter Color: White.
  - 2. Letter Height: 1/4 inch.
  - 3. Background Color: Black.
  - 4. Thickness: 1/8 inch.
  - 5. Plastic: Comply with ASTM D709.

**2.03 TAGS**

- A Manufacturers:
  - 1. Advanced Graphic Engraving, LLC: [www.advancedgraphicengraving.com/#sle](http://www.advancedgraphicengraving.com/#sle).
  - 2. Brady Corporation: [www.bradycorp.com/#sle](http://www.bradycorp.com/#sle).
  - 3. Brimar Industries, Inc: [www.pipemarker.com/#sle](http://www.pipemarker.com/#sle).
  - 4. Kolbi Pipe Marker Company: [www.kolbipipemarkers.com/#sle](http://www.kolbipipemarkers.com/#sle).
  - 5. Seton Identification Products, a Tricor Direct Company: [www.seton.com/#sle](http://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.
- C Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges.

- D Valve Tag Chart: Typewritten letter size list in anodized aluminum frame.

#### 2.04 STENCILS

- A Manufacturers:
1. Brady Corporation: [www.bradycorp.com/#sle](http://www.bradycorp.com/#sle).
  2. Kolbi Pipe Marker Company: [www.kolbipipemarkers.com/#sle](http://www.kolbipipemarkers.com/#sle).
  3. Seton Identification Products, a Tricor Direct Company: [www.seton.com/#sle](http://www.seton.com/#sle).
- B Stencils: With clean cut symbols and letters of following size:
1. 3/4 to 1-1/4 inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 1/2 inch high letters.
  2. 1-1/2 to 2 inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 3/4 inch high letters.
  3. 2-1/2 to 6 inch Outside Diameter of Insulation or Pipe: 12 inch long color field, 1-1/4 inch high letters.
  4. 8 to 10 inch Outside Diameter of Insulation or Pipe: 24 inch long color field, 2-1/2 inch high letters.
  5. Over 10 inch Outside Diameter of Insulation or Pipe: 32 inch long color field, 3-1/2 inch high letters.
  6. Equipment: 2-1/2 inch high letters.
- C Paint for Stencils: As specified in Section 09 91 23, semi-gloss enamel, colors complying with ASME A13.1.

#### 2.05 PIPE MARKERS

- A Manufacturers:
1. Brady Corporation: [www.bradycorp.com/#sle](http://www.bradycorp.com/#sle).
  2. Brimar Industries, Inc: [www.pipemarker.com/#sle](http://www.pipemarker.com/#sle).
  3. Kolbi Pipe Marker Company: [www.kolbipipemarkers.com/#sle](http://www.kolbipipemarkers.com/#sle).
  4. Seton Identification Products, a Tricor Company: [www.seton.com/#sle](http://www.seton.com/#sle).
- B Color: Comply with ASME A13.1.
- C 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.
- D Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.
- E Underground Plastic Pipe Markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.
- F Color code as follows:
1. Fire Quenching Fluids: Red with white letters.

#### 2.06 CEILING TACKS

- A Manufacturers:
1. Craftmark Pipe Markers: [www.craftmarkid.com/#sle](http://www.craftmarkid.com/#sle).
  2. Seton Identification Products, a Tricor Company;.
  3. Kolbi Pipe Marker Company;.
- B Description: Steel with 3/4 inch diameter color coded head.
- C Color code as follows:
1. Sprinkler Valves: Red.

### PART 3 EXECUTION

#### 3.01 PREPARATION

- A Degrease and clean surfaces to receive adhesive for identification materials.
- B Prepare surfaces in accordance with Section 09 91 23 for stencil painting.

#### 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 91 23.
- D Install plastic pipe markers in accordance with manufacturer's instructions.
- E Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.
- F Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.
- G 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.
- H Locate ceiling tacks to locate valves above T-bar type panel ceilings. Locate in corner of panel closest to equipment.

**END OF SECTION 21 05 53**

**SECTION 21 07 19**  
**FIRE SUPPRESSION PIPING INSULATION**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A Piping insulation.
- B Jacketing and accessories.

**1.02 RELATED REQUIREMENTS**

- A Section 07 84 00 - Firestopping.

**1.03 REFERENCE STANDARDS**

- A ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2023.
- B ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2021a.
- C ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2018b.
- D UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

**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.

**END OF SECTION 21 07 19**

**SECTION 21 11 00**  
**FACILITY FIRE-SUPPRESSION WATER-SERVICE PIPING**

**PART 2 PRODUCTS**

**END OF SECTION 21 11 00**

**SECTION 21 13 00**  
**FIRE-SUPPRESSION SPRINKLER SYSTEMS**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A Wet-pipe sprinkler system.
- B Dry-pipe sprinkler system.
- C Deluge sprinkler system.
- D Preaction sprinkler system.
- E System design, installation, and certification.
- F Fire department connections.

**1.02 REFERENCE STANDARDS**

- A FM (AG) - FM Approval Guide; Current Edition.
- B ICC-ES AC01 - Acceptance Criteria for Expansion Anchors in Masonry Elements; 2015.
- C ICC-ES AC106 - Acceptance Criteria for Predrilled Fasteners (Screw Anchors) in Masonry Elements; 2015.
- D ICC-ES AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements; 2015.
- E ICC-ES AC308 - Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements; 2016.
- F ITS (DIR) - Directory of Listed Products; current edition.
- G NFPA 13 - Standard for the Installation of Sprinkler Systems; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- H NFPA 1963 - Standard for Fire Hose Connections; 2019.
- I UL (DIR) - Online Certifications Directory; Current Edition.
- J UL 405 - Standard for Safety Fire Department Connection Devices; Current Edition, Including All Revisions.

**1.03 ADMINISTRATIVE REQUIREMENTS**

- A Preinstallation Meeting: Convene minimum one week before starting work of this section.

**1.04 SUBMITTALS**

- A Fire Protection Contractor shall acquire or perform their own Flow Test meeting the requirements of NFPA 291 and submit for review with the Submittals required by this section.
- B Product Data: Provide data on sprinklers, valves, and specialties, including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.
- C Provide Hydraulic Calculations, including safety factors where applicable, and per NFPA 13, supporting fire protection sprinkler system design illustrated in Shop Drawings
- D Shop Drawings:
  - 1. Submit preliminary layout of finished ceiling areas indicating only sprinkler locations coordinated with ceiling installation.
  - 2. Indicate hydraulic calculations, detailed pipe layout, hangers and supports, sprinklers, components, and accessories. Indicate system controls.
  - 3. Submit shop drawings to Authorities Having Jurisdiction for approval. Submit proof of approval to Architect. Note: Confirm process with Owner Rep and Architect prior to submittal to AHJ.
- E Manufacturer's Certificate: Certify that system has been tested and meets or exceeds specified requirements and code requirements.
- F Operation and Maintenance Data: Include components of system, servicing requirements, record drawings, inspection data, replacement part numbers and availability, and location and numbers of service depot.
- G Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
  - 1. Extra Sprinklers: Type and size matching those installed in quantity required by referenced NFPA design and installation standard.
  - 2. Sprinkler Wrenches: For each sprinkler type.
- H Project Record Documents: Record actual locations of sprinklers and deviations of piping from drawings. Indicate drain and test locations.

**1.05 QUALITY ASSURANCE**

- A Maintain one copy of referenced design and installation standard on site.

- B Comply with FM (AG) requirements.
- C Designer Qualifications: Design system under direct supervision of a minimum Nicet Level III Wet Sprinkler System designer experienced in design of this type of work and licensed in the State in which the Project is located.
- D Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- E Installer Qualifications: Company specializing in performing the work of this section with minimum \_\_\_\_\_ years experience and approved by manufacturer.
- F Equipment and Components: Provide products that bear FM (AG) label or marking.
- G Products Requiring Electrical Connection: Listed and classified by UL (DIR) as suitable for the purpose specified and indicated.

#### 1.06 DELIVERY, STORAGE, AND HANDLING

- A Store products in shipping containers and maintain in place until installation. Provide temporary inlet and outlet caps. Maintain caps in place until installation.

### PART 2 PRODUCTS

#### 2.01 MANUFACTURERS

- A Sprinklers, Valves, and Equipment:
  - 1. Tyco Fire Protection Products: [www.tyco-fire.com/#sle](http://www.tyco-fire.com/#sle).
  - 2. Viking Corporation: [www.vikinggroupinc.com/#sle](http://www.vikinggroupinc.com/#sle).
  - 3. Globe.
  - 4. Reliable

#### 2.02 SPRINKLER SYSTEM

- A Sprinkler System: Provide coverage for entire building.
- B Occupancy: Light hazard; comply with NFPA 13.
- C Water Supply: Determine volume and pressure from water flow test data.
  - 1. Revise design when updated and/or current test data is available prior to submittals.
- D Provide fire department connections where indicated.
- E Storage Cabinet for Spare Sprinklers and Tools: Steel, located adjacent to alarm valve.
- F Pipe Hanger Fasteners: Attach hangers to structure using appropriate fasteners, as follows:
  - 1. Concrete Wedge Expansion Anchors: Complying with ICC-ES AC193.
  - 2. Masonry Wedge Expansion Anchors: Complying with ICC-ES AC01.
  - 3. Concrete Screw Type Anchors: Complying with ICC-ES AC193.
  - 4. Masonry Screw Type Anchors: Complying with ICC-ES AC106.
  - 5. Concrete Adhesive Type Anchors: Complying with ICC-ES AC308.

#### 2.03 SPRINKLERS

- A Suspended Ceiling Type: Semi-recessed pendant type with matching push on escutcheon plate.
  - 1. Response Type: Quick.
  - 2. Coverage Type: Standard.
  - 3. Finish: Enamel, color WHITE .
  - 4. Fusible Link: Fusible solder link type temperature rated for specific area hazard.
- B Exposed Area Type: Pendant type with guard.
  - 1. Response Type: Quick.
  - 2. Coverage Type: Standard.
  - 3. Finish: Brass.
  - 4. Fusible Link: Fusible solder link type temperature rated for specific area hazard.
- C Sidewall Type: Semi-recessed horizontal sidewall type with matching push on escutcheon plate.
  - 1. Response Type: Quick.
  - 2. Coverage Type: Standard.
  - 3. Finish: Brass.
  - 4. Fusible Link: Fusible solder link type temperature rated for specific area hazard.
- D Dry Sprinklers: Concealed pendant type with matching push on escutcheon plate.
  - 1. Response Type: Quick.

2. Coverage Type: Standard.
  3. Finish: Brass.
  4. Fusible Link: Fusible solder link type temperature rated for specific area hazard.
- E Storage Sprinklers: Pendant type with guard.
1. Response Type: Standard.
  2. Coverage Type: Standard.
  3. Finish: Chrome plated.
  4. Fusible Link: Fusible solder link type temperature rated for specific area hazard.
- F Guards: Finish to match sprinkler finish.
- G Spray Nozzles: Brass with solid cone discharge, 30 degrees of arc with blow-off dust cap.
1. Finish: Brass.
- H Flexible Drop System: Stainless steel, multiple use, open gate type.
1. Application: Use to properly locate sprinkler heads.
  2. Include all supports and bracing.
  3. Provide braided type tube as required for the application.
  4. Manufacturers:
    - a. Victaulic Company; Vic-Flex: [www.victaulic.com/#sle](http://www.victaulic.com/#sle).
    - b. FM and UL listed approved equals.

#### 2.04 PIPING SPECIALTIES

- A Wet Pipe Sprinkler Alarm Valve: Check type valve with divided seat ring, rubber-faced clapper to automatically actuate water motor alarm, pressure retard chamber and variable pressure trim with the following additional capabilities and features:
1. Activate electric alarm.
  2. Test and drain valve.
  3. Replaceable internal components without removing valve from installed position.
  4. Manufacturers:
    - a. Victaulic Company; Series 751 with Series 760 motor alarm: [www.victaulic.com/#sle](http://www.victaulic.com/#sle).
- B Backflow Preventer: Reduced pressure principle valve assembly backflow preventer with drain and OS & Y gate valve on each end.
1. Manufacturers:
- C Test Connections:
1. Inspector's Test Connection for Preaction Systems:
    - a. Provide test connections approximately 6 ft above floor for each or portion of each sprinkler system equipped with an alarm device, located at the most remote part of each system.
    - b. Route test connection to an open-site drain location, excluding janitor sinks, accepting full flow without negative consequences.
    - c. Supply discharge orifice with same size as corresponding sprinkler orifice.
  2. Backflow Preventer Test Connection:
    - a. Provide downstream of the backflow prevention assembly, listed hose valves with 2.5 inch National Standard male hose threads with cap and chain.
    - b. Furnish one valve for each 250 gpm of system demand or fraction thereof.
    - c. Provide permanent sign reading "Test Valve" in accordance with Section 22 05 53.
- D Electric Alarm: Electrically operated chrome plated gong with pressure alarm switch.
- E Water Flow Switch: Vane type switch for mounting horizontal or vertical, with two contacts; rated 10 amp at 125 volt AC and 2.5 amp at 24 volt DC.
- F Fire Department Connections:
1. **Type: Exposed, projected wall mount made of corrosion resistant metal complying with UL 405. Equip FDC with 5-Inch Storz Fitting Connections for Compliance with Wilson Fire Department Requirements. Verify with Local AHJ prior to fabricating pump package.**
    - a. Inlets: Two way, 2-1/2 inch swivel fittings, internal threaded. Thread size and inlets according to NFPA 1963 or Authority Having Jurisdiction. Brass caps with gaskets, chains, and lugs.
    - b. Outlet: Back with pipe threads, 4 NPS.



- c. Rated Working Pressure: 175 psi.
- d. Finish: Chrome.
- e. Sleeve: Brass, 18 inches height.
- f. Signage: Raised or engraved lettering 1 inch minimum indicating system type.

### **PART 3 EXECUTION**

#### **3.01 INSTALLATION**

- A Install in accordance with referenced NFPA design and installation standard.
- B Install equipment in accordance with manufacturer's instructions.
- C Install buried shut-off valves in valve box. Provide post indicator.
- D Provide approved double check valve assembly at sprinkler system water source connection.
- E Locate fire department connection with sufficient clearance from walls, obstructions, or adjacent siamese connectors to allow full swing of fire department wrench handle.
- F Locate outside alarm gong on building wall as indicated.
- G Place pipe runs to minimize obstruction to other work.
- H Place piping in concealed spaces above finished ceilings.
- I Center sprinklers in two directions in ceiling tile and provide piping offsets as required.
- J Apply masking tape or paper cover to ensure concealed sprinklers, cover plates, and sprinkler escutcheons do not receive field paint finish. Remove after painting. Replace painted sprinklers.
- K Install and connect to fire pump system in accordance with Section 21 30 00.
- L Flush entire piping system of foreign matter.
- M Install guards on sprinklers where indicated.
- N Hydrostatically test entire system.
- O Require test be witnessed by Fire Marshal.

#### **3.02 INTERFACE WITH OTHER PRODUCTS**

- A Ensure required devices are installed and connected as required to fire alarm system.

**END OF SECTION 21 13 00**

**SECTION 21 30 00**  
**FIRE PUMPS**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A Fire pump package, including fire pump, diesel engine drive, controllers, enclosure, and accessories.
- B Electric jockey pump.
- C System maintenance.

**1.02 REFERENCE STANDARDS**

- A FM (AG) - FM Approval Guide; Current Edition.
- B ITS (DIR) - Directory of Listed Products; current edition.
- C NEMA MG 1 - Motors and Generators; 2018.
- D NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2020.
- E NFPA 13 - Standard for the Installation of Sprinkler Systems; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F NFPA 20 - Standard for the Installation of Stationary Pumps for Fire Protection; 2022.
- G NFPA 37 - Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines; 2021.
- H UL (DIR) - Online Certifications Directory; Current Edition.
- I UL 448 - Centrifugal Stationary Pumps for Fire-Protection Service; Current Edition, Including All Revisions.
- J UL 778 - Standard for Motor-Operated Water Pumps; Current Edition, Including All Revisions.
- K UL 1247 - Diesel Engines for Driving Centrifugal Fire Pumps; Current Edition, Including All Revisions.
- L UL 1478 - Fire Pump Relief Valves; Current Edition, Including All Revisions.

**1.03 ADMINISTRATIVE REQUIREMENTS**

- A Preinstallation Meeting: Convene four weeks before starting work of this section.

**1.04 SUBMITTALS**

- A Product Data: Provide manufacturers literature including general assembly, pump curves showing performance characteristics with pump and system, operating point indicated, NPSH curve, controls, wiring diagrams, and service connections.
- B *Shop Drawings: Indicate layout, general assembly, components, dimensions, weights, clearances, and methods of assembly for both Fire Pump and/or Pre-packaged Skid-Mounted Fire Pump and Enclosure where required.*
- C Certificates: Certify that fire pumps meet or exceed specified requirements at specified operating conditions and that the installation complies with regulatory requirements. Submit summary and results of shop tests performed in accordance with NFPA 20
- D Test Reports: Indicate results of hydrostatic test and field acceptance tests.
- E Manufacturer's Instructions: Indicate support details, connection requirements, for fire pump system.
- F Designer's Qualification Statement.
- G Manufacturer's Qualification Statement.
- H Installer's Qualification Statement.
- I Maintenance Contract.
- J Operation Data: Include manufacturers instructions, start-up data, trouble-shooting check lists, for pumps, drivers, and controllers.
- K Maintenance Data: Include manufacturers literature, cleaning procedures, replacement parts lists, and repair data for pumps, drivers and controllers.
- L Project Record Documents: Record actual locations of components and accessories.
- M Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
  - 1. Extra Pump Gaskets/Screens/Seals: One set for each different pump model.

**1.05 QUALITY ASSURANCE**

- A Comply with NFPA 13 and NFPA 20; where requirements differ comply with the most stringent.
- B Maintain on site at all times one copy of each design and installation standard referenced.
- C Design fire pump system under direct supervision of a minimum Nicet Level III Wet Sprinkler System designer experienced in design of this work and licensed at the State in which the Project is located.

- D Equipment and Components: Bearing FM (AG) label or marking.
- E Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.
- F Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- G Installer Qualifications: Company specializing in performing the work of this section with minimum 5 years experience.
- H Provide certificate of compliance from authority have jurisdiction indicating approval of field acceptance tests.

#### **1.06 DELIVERY, STORAGE, AND HANDLING**

- A Deliver fire pumps and components in factory packing. Comply with manufacturer's rigging and installation instructions.
- B Protect fire pumps and components from physical damage including effects of weather, water, and construction debris.
- C Provide temporary inlet and outlet caps, and maintain in place until installation.

### **PART 2 PRODUCTS**

#### **2.01 FIRE PUMPS**

- A Manufacturers:
  - 1. AC Fire Pump, a xylem brand: [www.acfirepump.com/#sle](http://www.acfirepump.com/#sle).
  - 2. Patterson Pump Company, a Gorman-Rupp Company: [www.pattersonpumps.com/#sle](http://www.pattersonpumps.com/#sle).
  - 3. Peerless Pump Company: [www.peerlesspump.com/#sle](http://www.peerlesspump.com/#sle).
  - 4. SPP Pumps, Inc: [www.spppumps.com/#sle](http://www.spppumps.com/#sle).
- B Fire Pumps: Vertical in-line type; UL 448 and UL 778; single stage, close coupled, radially or horizontally split casing, for in-line mounting, for 250 psi.
  - 1. Casing: Cast or ductile iron, with suction and discharge gauge port, casing wear ring, seal flush connection, drain plug, flanged suction and discharge.
  - 2. Impeller: Bronze, fully enclosed, keyed directly to motor shaft.
  - 3. Shaft: Solid alloy steel with bronze sleeve.
  - 4. Seal: Packing gland with minimum four rings graphite impregnated packing and bronze lantern rings, 230 degrees F maximum continuous operating temperature.
- C Accessories:
  - 1. Eccentric suction reducer and OS&Y gate or butterfly valve on suction side of pump.
  - 2. Concentric increaser and check valve in pump discharge and OS&Y gate or butterfly valve on system side of check valve.
  - 3. Fire pump bypass fitted with OS&Y gate or butterfly valves and check valve.
  - 4. Main relief valve, UL 1478 and enclosed type waste cone.
  - 5. Suction pressure gauge, 4-1/2 inch diameter dial with snubber, valve cock and lever handle.
  - 6. Discharge pressure gauge mounted on board attached to pump, with snubber, valve cock and lever handle.
  - 7. 3/4 inch casing relief valve.
  - 8. Float operated 3/4 inch automatic air release valve.
  - 9. Hose valve manifold with 2-1/2 inch hose gate valves with caps and chains.
  - 10. Flow metering system for closed loop testing.

#### **2.02 DIESEL ENGINE DRIVE:**

- A Diesel Engine: Comply with requirements of NFPA 37 and UL 1247; automatic operation with overspeed/overcrank switch and drive, two contactor switches, low oil pressure and high water temperature warning switches, and fuel shut-off solenoid, with wiring terminating in junction box.
- B Cooling Water System: Closed system with cooling water supply to heat exchanger from fire pump discharge. Include four manual shut-off valves (including by-pass line), two strainers, pressure regulating valve, automatic solenoid valve and pressure gauge.
- C Storage Batteries: Dual lead acid batteries with cables and battery racks.

- D Fuel System: above ground storage tank, fill pipe and cap, manual shut-off valve, flame arrestor, oil level gauge, braided bronze flexible connectors, seamless type L copper tubing with flared joints. Fill tank at completion.
- E Engine Controller: Automatic; drive enclosed in floor mounted 14 gage, 0.0747 inch steel housing, UL (DIR) listed and labelled.
  - 1. Controller: Function to automatically start fire pump from water pressure control switch or test switch.
  - 2. Stop Push Button: To manually stop engine.
  - 3. Automatic Conditions: Controller shall alternate batteries automatically on each 15 second cranking cycle. Alarm if engine not started after six attempts.
  - 4. Battery Charger: Dual, built-in, to recharge both batteries within 24 hour period, with automatic overload protection (current limiting), individual voltmeters and ammeters for each battery.

### 2.03 PRESSURE BOOSTER (JOCKEY) PUMP

- A Manufacturers:
  - 1. Armstrong Pumps Inc: [www.armstrongpumps.com/#sle](http://www.armstrongpumps.com/#sle).
  - 2. Grundfos: [www.us.grundfos.com/#sle](http://www.us.grundfos.com/#sle).
  - 3. Talco Fire Systems: [www.talcofire.com/#sle](http://www.talcofire.com/#sle).
  - 4. AC Fire Pump (Xylem).
- B Electrically operated, horizontal turbine type with standard open drip-proof horizontal motor.
- C Control by automatic jockey pump controller with full voltage starter and minimum run timer to start pump on pressure drop in system and stay in operation for minimum period of time. Fire pump shall start automatically on further pressure drop or on jockey pump failure.

### 2.04 PRE-PACKAGED SKID-MOUNTED FIRE PUMP ENCLOSURES

- A *Provide Fire Pump Enclosure by same manufacturer of Fire Pump or by company contracted to Fire Pump Manufacturer for construction of enclosures for Fire Pump Manufacturer - Contractor Built Enclosures or Enclosures purchased separately from Fire Pump will not be allowed.*
- B *Fire Pump and Enclosure manufacturers and products must be NFPA, FM, and UL Listed and/or approved.*
- C *System shall be constructed of pre-engineered components factory mounted to steel skid base and all piping shall be hydrostatically tested prior to shipping.*
- D *Enclosure Floor shall be constructed of Steel Framework components of 12, 14, and 16 Gauge Steel minimum, protected from the elements by Galvanizing or approved equal finishing method, and designed for the loads of the packaged pump and enclosure elements.*
- E *Provide Slip Resistant Steel Deck Plate Flooring*
- F *Enclosure walls shall be min. 22 gauge steel liner panels with concealed fasteners and min. 3-1/2" R-14 High Density Insulation with a min. 1" thermal break of Insulating Blanket Insulation. Provide color selection materials, including custom colors available, for Architect's review and selection.*
- G *Enclosure Roof shall be of Solid Web Steel Roof Trusses and steel purlins protected from the elements by Galvanizing or approved equal finishing method, and 18 gauge ribbed steel roofing panels with single slope.*
- H *Enclosure Roof, Ceiling, and exterior and interior faces of wall panels shall be finished with Factory Kynar 500 baked on Polyester Resin Finish or approved equal finish. Provide color selection materials, including custom colors available, for Architect's review and selection.*
- I *Enclosure shall be factory pre-wired to accept a single external electrical connection in the field and meet all NFPA and NEC and Electrical Building Code requirements.*
- J *Enclosure shall come equipped with factory installed exhaust fan and heater as required.*

## PART 3 EXECUTION

### 3.01 INSTALLATION

- A Install in accordance with NFPA 20.
- B Install diesel engine drive in accordance with NFPA 37.
- C Provide access space around pumps for service; no less than minimum as recommended by manufacturer.
- D Install piping in accordance with Section 21 05 00. 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

base mounted pumps, provide supports under elbows on pump suction and discharge.

- E Provide drains for bases and seals, piped to and discharging into floor drains.
- F Mount unit on vibration isolators. Refer to Section 21 05 48.
- G Provide piping for fuel supply and return connected to engine drive. Provide piping to and from exhaust silencer with thimble at wall or roof penetrations. Refer to Section 23 11 13.
- H Insulate piping associated with pump, pump casing and exhaust silencer. Refer to Section 21 07 16 and Section 21 07 19.
- I Provide for connection to electrical service. Refer to Section 26 05 83.
- J Lubricate pumps before start-up.
- K Check, align, and certify pumps by qualified installer prior to start-up.

### **3.02 FIELD QUALITY CONTROL**

- A Perform field inspection and testing in accordance with Section 01 40 00 - Quality Requirements.
- B Perform hydrostatic tests, flushing, and field acceptance tests as specified in NFPA 20.
- C Perform field acceptance tests in the presence of Fire Marshal.

### **3.03 CLOSEOUT ACTIVITIES**

- A Demonstration:
- B Demonstrate automatic operation of system including verification of pressure switch set points to Owner.
- C Use operation and maintenance data as reference during demonstration.
- D Briefly describe function, operation, and maintenance of each component.
- E Conduct walking tour of project.
- F 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.

### **3.04 MAINTENANCE**

- A Provide a separate maintenance contract for specified maintenance service.
- B Perform maintenance using competent personnel in the direct employ of the system installer.
- C Provide service and maintenance of equipment installed under this section for one year from the Date of Substantial Completion.

**END OF SECTION 21 30 00**

**SECTION 22 05 13**

**COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A General construction and requirements.
- B Applications.

**1.02 REFERENCE STANDARDS**

- A NEMA MG 1 - Motors and Generators; 2018.
- B NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

**PART 2 PRODUCTS**

**2.01 GENERAL CONSTRUCTION AND REQUIREMENTS**

- A Construction:
  - 1. Open drip-proof type except where specifically noted otherwise.
  - 2. Design for continuous operation in 104 degrees F environment.
  - 3. Design for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
- B Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.
- C Wiring Terminations:
  - 1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.
  - 2. For fractional horsepower motors where connection is made directly, provide threaded conduit connection in end frame.

**2.02 APPLICATIONS**

**END OF SECTION 22 05 13**

**SECTION 22 05 16**

**EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A Flexible pipe connectors.
- B Expansion joints and compensators.
- C Pipe loops, offsets, and swing joints.

**1.02 REFERENCE STANDARDS**

- A ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250; 2020.
- B ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard; 2020.
- C ASME B16.11 - Forged Fittings, Socket-Welding and Threaded; 2021.
- D ASTM A269/A269M - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service; 2022.
- E EJMA (STDS) - EJMA Standards; Tenth Edition.
- F FM (AG) - FM Approval Guide; Current Edition.
- G ITS (DIR) - Directory of Listed Products; current edition.
- H UL (DIR) - Online Certifications Directory; Current Edition.

**1.03 SUBMITTALS**

- A Product Data:
  - 1. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.
  - 2. Expansion Joints: Indicate maximum temperature and pressure rating, and maximum expansion compensation.
- B Manufacturer's Instructions: Indicate manufacturer's installation instructions, special procedures, and external controls.
- C Maintenance Data: Include adjustment instructions.
- D Project Record Documents: Record installed locations of flexible pipe connectors, expansion joints, anchors, and guides.

**PART 2 PRODUCTS**

**2.01 REGULATORY REQUIREMENTS**

- A Comply with UL (DIR) requirements.

**PART 3 EXECUTION**

**3.01 INSTALLATION**

- A Install in accordance with manufacturer's instructions.
- B Install in accordance with EJMA (Expansion Joint Manufacturers Association) Standards.
- C Install flexible pipe connectors on pipes connected to vibration isolated equipment. Provide line size flexible connectors.
- D Install flexible connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor other end. Install in horizontal plane unless indicated otherwise.
- E Anchor pipe to building structure where indicated. Provide pipe guides so movement is directed along axis of pipe only. Erect piping such that strain and weight is not on cast connections or apparatus.
- F Provide support and equipment required to control expansion and contraction of piping. Provide loops, pipe offsets, and swing joints, or expansion joints where required.

**END OF SECTION 22 05 16**

**SECTION 22 05 17**  
**SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A Pipe sleeves.
- B Pipe sleeve-seals.

**1.02 REFERENCE STANDARDS**

- A ASTM C592 - Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type); 2022a.
- B ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems; 2013a (Reapproved 2017).

**1.03 SUBMITTALS**

- A Shop Drawings: Indicate pipe materials used, jointing methods, supports, floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.
- B Product data: Pipe Sleeve-Seals

**1.04 QUALITY ASSURANCE**

- A Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum seven years documented experience.
- B Installer Qualifications: Company specializing in performing work of the type specified this section.
  - 1. Minimum three years experience.
  - 2. Approved by manufacturer.
- C Clean equipment, pipes, valves, and fittings of grease, metal cuttings, and sludge that may have accumulated from the installation and testing of the system.

**1.05 DELIVERY, STORAGE, AND HANDLING**

- A Deliver and store sleeve and sleeve seals in shipping containers, with labeling in place.
- B Provide temporary protective coating on cast iron and steel sleeves if shipped loose.

**1.06 WARRANTY**

- A Correct defective Work within a five year period after Date of Substantial Completion.

**PART 2 PRODUCTS**

**2.01 PIPE SLEEVES**

- A Manufacturers:
  - 1. Flexicraft Industries
  - 2. GPT Industries - LinkSeal
  - 3. Metraflex
  - 4. EJ Prescott
- B Vertical Piping:
  - 1. Schedule 40 steel sleeve
  - 2. Sleeve Length: 2 inches above finished floor.
  - 3. Provide silicone sealant for watertight joint when not a rated penetration.
  - 4. Blocked Out Floor Openings: Provide 1-1/2 inch angle set in silicon adhesive around opening.
  - 5. Drilled Penetrations: Provide 1-1/2 inch angle ring or square set in silicone adhesive around penetration.
- C Pipe passing through interior walls and/or non-rated partitions
  - 1. Schedule 40 steel sleeve. Pack opening with mineral wool.
- D Pipe Passing Through Below Grade Exterior Walls:
  - 1. Provide watertight space with link rubber or modular seal between sleeve and pipe on both pipe ends.
- E Pipe Passing Through Mechanical, Laundry, and Animal Room Floors above Basement:
  - 1. Galvanized steel pipe or black iron pipe with asphalt coating.
  - 2. Connect sleeve with floor plate except in mechanical rooms.
- F Clearances:
  - 1. Provide allowance for insulated piping.



2. Wall, Floor, Floor, Partitions, and Beam Flanges: 1 inch greater than external pipe diameter, including insulation.
3. All Rated Openings: Caulked tight with fire stopping material complying with ASTM E814 in accordance with Section 07 84 00 to prevent the spread of fire, smoke, and gases.

## **2.02 PIPE-SLEEVE SEALS**

- A Manufacturers:
1. Flexicraft Industries; PipeSeal: [www.flexicraft.com/#sle](http://www.flexicraft.com/#sle).
  2. GPT Industries - LinkSeal.
  3. Metraflex.
- B Modular Mechanical Seal:
1. Synthetic rubber interlocking links continuously fill annular space between pipe and wall/casing opening.
  2. Provide watertight seal between pipe and wall/casing opening.
  3. Elastomer element size and material in accordance with manufacturer's recommendations.
  4. Glass reinforced plastic pressure end plates.
- C Sealing Compounds:
1. Provide packing and sealing compound to fill pipe to sleeve thickness.
  2. Combined packing and sealing compounding to match partition fire-resistance hourly rating.

## **PART 3 EXECUTION**

### **3.01 PREPARATION**

- A Ream pipe and tube ends. Remove burrs.
- B Remove scale and foreign material, from inside and outside, before assembly.

### **3.02 INSTALLATION**

- A Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.
- B Install piping to conserve building space, to not interfere with use of space and other work.
- C Install piping and pipe sleeves to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Pipe Sleeves shall be sized with clearances around pipe based on Code Required Dimensions.
- D Structural Considerations: Do not penetrate building structural members unless indicated.
- E Provide sleeves when penetrating all footings, floors, and walls. Seal pipe including sleeve penetrations to achieve fire resistance equivalent to fire separation required.
- F Manufactured Sleeve-Seal Systems:
1. Install manufactured sleeve-seal systems in sleeves located in grade slabs and exterior concrete walls at piping entrances into building.
  2. Provide sealing elements of the size, quantity, and type required for the piping and sleeve inner diameter or penetration diameter.
  3. Locate piping in center of sleeve or penetration.
  4. Install field assembled sleeve-seal system components in annular space between sleeve and piping.
  5. Tighten bolting for a water-tight seal.
  6. Install in accordance with manufacturer's recommendations.
- G When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

### **3.03 CLEANING**

- A Upon completion of work, clean all parts of the installation.
- B Clean equipment, pipes, valves, and fittings of grease, metal cuttings, and sludge that may have accumulated from the installation and testing of the system.

**END OF SECTION 22 05 17**

**SECTION 22 05 19**  
**METERS AND GAUGES FOR PLUMBING PIPING**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A Positive displacement meters.
- B Flow meters.
- C Pressure gauges and pressure gauge taps.
- D Thermometers and thermometer wells.
- E Static pressure gauges.
- F Filter gauges.

**1.02 REFERENCE STANDARDS**

- A ASME B40.100 - Pressure Gauges and Gauge Attachments; 2022.
- B ASTM E1 - Standard Specification for ASTM Liquid-in-Glass Thermometers; 2014 (Reapproved 2020).
- C ASTM E77 - Standard Test Method for Inspection and Verification of Thermometers; 2014 (Reapproved 2021).
- D AWWA C700 - Cold-Water Meters -- Displacement Type, Metal Alloy Main Case; 2020.
- E AWWA C701 - Cold-Water Meters -- Turbine Type, for Customer Service; 2019.
- F AWWA C702 - Cold-Water Meters -- Compound Type; 2019.
- G AWWA M6 - Water Meters -- Selection, Installation, Testing, and Maintenance; 2012, with Addendum (2018).
- H UL 404 - Gauges, Indicating Pressure, for Compressed Gas Service; Current Edition, Including All Revisions.

**1.03 SUBMITTALS**

- A Product Data: Provide list that indicates use, operating range, total range and location for manufactured components.
- B Project Record Documents: Record actual locations of components and instrumentation.
- C Operation and Maintenance Data: For Closeout.
- D Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
  - 1. Extra Pressure Gauges: One of each type and size.

**1.04 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 POSITIVE DISPLACEMENT METERS (LIQUID)**

**2.02 LIQUID FLOW METERS**

- A Manufacturers:
  - 1. E-Mon
  - 2. Onicon Model F-1230
  - 3. SeaMetrics
- B Water Flow Meter shall be Dual Turbine Flow Meter with local mounted display module with digital display, complete with installation of all hardware necessary to enable insertion and removal of the meter without system shutdown.
  - 1. The flow meter shall be hand-insertable without system shutdown.
  - 2. The flow meter shall have dual turbines with jewel bearing systems, electronic impedance-based sensing and an averaging circuit to reduce measurement errors due to swirl and flow profile distortion.
  - 3. Wetted metal components shall be nickel-plated brass.
  - 4. The standard model maximum operating temperature shall be 180°F, 200°F peak, with ambient temperature range of -5°F to 160°F.
  - 5. Maximum operating pressure shall be 400 psi.
  - 6. Pressure drop shall be less than 1 psi at 20 ft/s in 2-1/2" pipe, decreasing in larger pipes and lower velocities.

7. Each flow meter shall be individually wet-calibrated against a primary volumetric standard traceable to NIST. The manufacturer's certificate of calibration shall be provided with each flow meter.
  8. Accuracy shall be within  $\pm 0.5\%$  of rate at the calibrated velocity, within  $\pm 1\%$  of rate over a 10:1 turndown (3.0 to 30 ft/s) and within  $\pm 2\%$  of rate over a 50:1 turndown (from 0.4 to 20ft/s).
  9. Electrical requirement 120/24, provide with control transformer.
  10. The flow meter shall include integral digital output, isolated solid state dry contact, 100mA, 50V divided output.
  11. The flow meter shall be covered by the manufacturer's two year warranty.
  12. Provide standard electrical connection, 10' of 5-wire cable with 3/4-in. NPT conduit connection.
- C Display Module shall be digital, converting the results of the insertion flow meter to display flow rate and total volume.
1. Housing shall be 6" x 6" x 4" NEMA 4 steel enclosure, wall mount.
  2. Electrical requirement shall be 120/1/60.
    - a. Output voltage (nominal): +24 VDC at 200mA.
  3. Indicators include multi-functioning LCD(s) with two buttons for mode selection, total reset, and programming, providing 6-digit rate and 8-digit totalization. (Total reset switch can be disabled via programming.)
  4. Programming is set at factory for particular flow meter and pipe size. Field programming is possible.
  5. Non volatile EEPROM memory retains all programming parameters in the event of power loss.
  6. Input is 0-15V pulse output from insertion flow meter.

### 2.03 PRESSURE GAUGES

- A Manufacturers:
1. Dwyer Instruments, Inc: [www.dwyer-inst.com](http://www.dwyer-inst.com).
  2. Moeller Instrument Co., Inc: [www.moellerinstrument.com](http://www.moellerinstrument.com).
  3. Omega Engineering, Inc: [www.omega.com](http://www.omega.com).
- B Pressure Gauges: ASME B40.100, UL 393 drawn steel case, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background.
1. Case: Steel with brass bourdon tube.
  2. Size: 4-1/2 inch diameter.
  3. Mid-Scale Accuracy: One percent.
  4. Scale: Psi.

### 2.04 PRESSURE GAUGE TAPPINGS

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

### 2.05 STEM TYPE THERMOMETERS

- A Manufacturers:
1. Dwyer Instruments, Inc: [www.dwyer-inst.com](http://www.dwyer-inst.com).
  2. Omega Engineering, Inc: [www.omega.com](http://www.omega.com).
  3. Weksler Glass Thermometer Corp: [www.wekslerglass.com](http://www.wekslerglass.com).
- B Thermometers - Fixed Mounting: Red- or blue-appearing non-toxic liquid in glass; ASTM E1; lens front tube, cast aluminum case with enamel finish.
1. Size: 9 inch scale.
  2. Window: Clear Lexan.
  3. Accuracy: 2 percentper ASTM E77.
  4. Calibration: Degrees F.
- C Thermometers - Adjustable Angle: Red- or blue-appearing non-toxic liquid in glass; ASTM E1; lens front tube, cast aluminum case with enamel finish, cast aluminum adjustable joint with positive locking device; adjustable 360 degrees in horizontal plane, 180 degrees in vertical plane.
1. Size: 9 inch scale.
  2. Window: Clear Lexan.
  3. Accuracy: 2 percentper ASTM E77.
  4. Calibration: Degrees F.

**2.06 THERMOMETER SUPPORTS**

- A Socket: Brass separable sockets for thermometer stems with or without extensions as required, and with cap and chain.

**2.07 TEST PLUGS**

- A Test Plug: 1/4 inch or 1/2 inch stainless steel fitting and cap for receiving 1/8 inch outside diameter pressure or temperature probe with Nordel core for temperatures up to 350 degrees F.
- B Test Kit: Carrying case, internally padded and fitted containing one 2-1/2 inch diameter pressure gauges, one gauge adapters with 1/8 inch probes, two 1 inch dial thermometers.

**2.08 STATIC PRESSURE GAUGES**

**PART 3 EXECUTION**

**3.01 INSTALLATION**

- A Install in accordance with manufacturer's instructions.
- B The Contractor shall set the flow metering system in service to operating conditions as a part of this contract.
- C Store all components prior to installation in clean, dry place to protect them from construction dirt, water etc. Handle with care to avoid damaging finish or internal components.
- D Provide one pressure gauge per pump, installing taps before strainers and on suction and discharge of pump. Pipe to gauge.
- E 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.
- F Coil and conceal excess capillary on remote element instruments.
- G Provide instruments with scale ranges selected according to service with largest appropriate scale.
- H Install gauges and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.
- I Adjust gauges and thermometers to final angle, clean windows and lenses, and calibrate to zero.
- J Locate test plugs adjacent thermometers and thermometer sockets.

**END OF SECTION 22 05 19**

**SECTION 22 05 23**

**GENERAL-DUTY VALVES FOR PLUMBING PIPING**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A Applications
- B General requirements
- C Angle valves
- D Ball valves
- E Butterfly valves
- F Check valves
- G Globe valves
- H Plug valves

**1.02 ABBREVIATIONS AND ACRONYMS**

- A CWP: Cold working pressure.
- B EPDM: Ethylene propylene copolymer rubber.
- C NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
- D NRS: Non-rising stem.
- E OS&Y: Outside screw and yoke.
- F PTFE: Polytetrafluoroethylene.
- G RS: Rising stem.
- H SWP: Steam working pressure.
- I TFE: Tetrafluoroethylene.
- J WOG: Water, oil, and gas.

**1.03 REFERENCE STANDARDS**

- A ASME B1.20.1 - Pipe Threads, General Purpose, Inch; 2013 (Reaffirmed 2018).
- B ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250; 2020.
- C ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard; 2020.
- D ASME B16.10 - Face-to-Face and End-to-End Dimensions of Valves; 2022.
- E ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2021.
- F ASME B16.34 - Valves — Flanged, Threaded, and Welding End; 2020.
- G ASME B31.9 - Building Services Piping; 2020.
- H ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators; 2023.
- I ASTM A48/A48M - Standard Specification for Gray Iron Castings; 2022.
- J ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings; 2004 (Reapproved 2019).
- K ASTM A536 - Standard Specification for Ductile Iron Castings; 1984, with Editorial Revision (2019).
- L ASTM B61 - Standard Specification for Steam or Valve Bronze Castings; 2015 (Reapproved 2021).
- M ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings; 2017.
- N AWWA C606 - Grooved and Shouldered Joints; 2022.
- O MSS SP-45 - Drain and Bypass Connections; 2020.
- P MSS SP-67 - Butterfly Valves; 2022.
- Q MSS SP-70 - Gray Iron Gate Valves, Flanged and Threaded Ends; 2011.
- R MSS SP-71 - Gray Iron Swing Check Valves, Flanged and Threaded Ends; 2018.
- S MSS SP-72 - Ball Valves with Flanged or Butt-Welding Ends for General Service; 2010a.
- T MSS SP-78 - Gray Iron Plug Valves, Flanged and Threaded Ends; 2011.
- U MSS SP-80 - Bronze Gate, Globe, Angle, and Check Valves; 2019.
- V MSS SP-85 - Gray Iron Globe and Angle Valves, Flanged and Threaded Ends; 2011.
- W MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; 2010, with Errata .
- X NSF 61 - Drinking Water System Components - Health Effects; 2022, with Errata.
- Y NSF 372 - Drinking Water System Components - Lead Content; 2022.

#### 1.04 SUBMITTALS

- A Product Data: Provide data on valves including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.
- B Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.
- C Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts listings.
- D Maintenance Materials: Furnish Owner with one wrench for every five plug valves, in each size of square plug valve head.

#### 1.05 QUALITY ASSURANCE

- A Manufacturer:
  - 1. Obtain valves for each valve type from single manufacturer.
  - 2. Company must specialize in manufacturing products specified in this section, with not less than 10 years of documented experience.
- B Welding Materials and Procedures: Comply with ASME BPVC-IX.

#### 1.06 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.

#### 1.07 EXERCISE THE FOLLOWING PRECAUTIONS FOR HANDLING:

- A Handle large valves with sling, modified to avoid damage to exposed parts.
- B Avoid the use of operating handles or stems as rigging or lifting points.

### PART 2 PRODUCTS

#### 2.01 APPLICATIONS

- A See drawings for specific valve locations.
- B NOTE - Gate Valves are not approved for use without specific prior approval from the engineer.
- C Balancing Valves (circuit setters) shall be Thermostatic Balancing Valves with Service/Shutoff Ball Valves at either end, inline strainer, and T&P Ports on either side of valve such as Circuit Solver by ThermOmegaTech Model CSUAS or approved equal.
- D Provide the following valves for the applications if not indicated on drawings:
  - 1. Shutoff: Ball valve required except may be Butterfly on 2-1/2" piping and larger
  - 2. Dead-End: Single-flange butterfly (lug) type.
  - 3. Throttling: Provide ball.
  - 4. Swing Check (Pump Outlet):
    - a. 2 NPS and Smaller: Bronze swing check valves with bronze disc.
    - b. 2-1/2 NPS and Larger for Domestic Water: Iron swing check valves with closure control or center-guided, metal or resilient seat check valves.
    - c. 2-1/2 NPS and Larger for Sanitary Waste and Storm Drainage: Iron swing check valves with lever and weight or spring.
- E Substitutions of valves with higher CWP classes or SWP ratings for same valve types are permitted when specified CWP ratings or SWP classes are not available.

- F Required Valve End Connections for Non-Wafer Types:
  - 1. Steel Pipe:
    - a. 2 NPS and Smaller: Threaded ends.
    - b. 2-1/2 NPS to 4 NPS: Grooved or flanged ends except where threaded valve-end option is indicated in valve schedules below.
    - c. 5 NPS and Larger: Grooved or flanged ends.
    - d. Grooved-End Copper Tubing and Steel Piping: Grooved.
  - 2. Copper Tube:
    - a. 2 NPS and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
    - b. 2-1/2 NPS to 4 NPS: Grooved or flanged ends except where threaded valve-end option is indicated in valve schedules below.
    - c. 5 NPS and Larger: Grooved or flanged ends.
- G Low Pressure, Compressed Air Valves 150 psig or Less:
  - 1. 2 NPS and Smaller:
    - a. Bronze and Brass: Provide with solder-joint, threaded, or press-fitting ends.
    - b. Ball: Two piece, full port, brass or bronze with stainless-steel trim.
    - c. Bronze Lift Check: Class 125, bronze disc.
    - d. Bronze Swing Check: Class 125, bronze disc.
- H High Pressure, Compressed Air Valves 150 psig to 200 psig:
  - 1. 2 NPS and Smaller:
    - a. Bronze and Brass: Provide with solder-joint or threaded ends.
    - b. Ball: Two piece, full port, brass or bronze with stainless-steel trim.
    - c. Bronze Lift Check: Class 125, bronze disc.
    - d. Bronze Swing Check: Class 125, bronze disc.
- I Domestic, Hot and Cold Water Valves:
  - 1. 2 NPS and Smaller:
    - a. Bronze and Brass: Provide with solder-joint, threaded, or press-fitting ends.
    - b. Bronze Angle: Class 125, bronze disc.
    - c. Ball: Two piece, full port, brass or bronze with stainless-steel trim.
    - d. Bronze Swing Check: Class 125, bronze disc.
    - e. Bronze Gate: Class 125, NRS.
    - f. Bronze Globe: Class 125, bronze disc.
  - 2. 2-1/2 NPS and Larger:
    - a. Iron, 2-1/2 NPS to 4 NPS: Provide with threaded or flanged ends.
    - b. Iron Ball: Class 150.
    - c. Iron Single-Flange Butterfly: 200 CWP, EPDM seat, aluminum-bronze disc.
    - d. Iron Grooved-End Butterfly: 175 CWP.
    - e. Iron Swing Check: Class 125, metal seats.
    - f. Iron Swing Check with Closure Control: Class 125, lever and spring.
    - g. Iron Grooved-End Swing Check: 300 CWP.
    - h. Iron Center-Guided Check: Class 125, compact-wafer, metal seat.
    - i. Iron Plate-Type Check: Class 125; single plate; metal seat.
    - j. Iron Globe: Class 125.
- J Sanitary Waste, Storm Drainage, and Force-Main Piping Water Valves:
  - 1. 2 NPS and Smaller:
    - a. Bronze and Brass: Provide with solder-joint or threaded.
    - b. Bronze Angle: Class 125, bronze disc.
    - c. Ball: One piece, full port, brass or bronze with stainless-steel trim.
    - d. Bronze Swing Check: Class 125, bronze disc.
    - e. Bronze Gate: Class 125, NRS.
    - f. Bronze Globe: Class 125, bronze disc.

2. 2-1/2 NPS and Larger:
  - a. Iron, 2-1/2 NPS to 4 NPS: Provide with threaded or flanged ends.
  - b. Iron Ball: Class 150.
  - c. Iron Swing Check: Class 125, metal seats.
  - d. Iron Swing Check with Closure Control: Class 125, lever and spring.
  - e. Iron Grooved-End Swing Check: 300 CWP.
  - f. Iron Gate: Class 125, NRS.
  - g. Iron Globe: Class 125.
  - h. Lubricated Plug: Class 125, regular gland.

## 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. Gear Actuator: Quarter-turn valves 8 NPS and larger.
  2. Handwheel: Valves other than quarter-turn types.
  3. Hand Lever: Quarter-turn valves 6 NPS and smaller except plug valves.
  4. Wrench: Plug valves with square heads.
- D Valves in Insulated Piping: With 2 NPS stem extensions and the following features:
  1. 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.
  2. Butterfly Valves: Extended neck.
  3. Memory Stops: Fully adjustable after insulation is installed.
- 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. Pipe Flanges and Flanged Fittings 1/2 NPS through 24 NPS: ASME B16.5.
  4. Solder Joint Connections: ASME B16.18.
  5. Grooved End Connections: AWWA C606.
- F General ASME Compliance:
  1. Ferrous Valve Dimensions and Design Criteria: ASME B16.10 and ASME B16.34.
  2. Solder-joint Connections: ASME B16.18.
  3. Building Services Piping Valves: ASME B31.9.
- G Valve Materials for Potable Water: NSF 61 and NSF 372.
- H Bronze Valves:
  1. Fabricate from dezincification resistant material.
  2. Copper alloys containing more than 15 percent zinc are not permitted.
- I Valve Bypass and Drain Connections: MSS SP-45.
- J Source Limitations: Obtain each valve type from a single manufacturer.

## 2.03 BRONZE ANGLE VALVES

- A Class 125: CWP Rating: 200 psig:
  1. Comply with MSS SP-80, Type 1.
  2. Body: Bronze; ASTM B62, with integral seat and screw in bonnet.
  3. Ends: Threaded
  4. Stem: Bronze
  5. Disc: Bronze
  6. Packing: Asbestos free
  7. Handwheel: Bronze or aluminum

## 2.04 BRASS BALL VALVES

- A Two Piece, Full Port with Stainless Steel Trim:
  1. Comply with MSS SP-110
  2. SWP Rating: 150 psig.



3. CWP Rating: 600 psig.
4. Body: Forged brass.
5. Ends: Threaded or soldered
6. Seats: PTFE or TFE
7. Stem: Stainless Steel
8. Ball: Chrome-plated brass

**2.05 BRONZE BALL VALVES**

- A Two Piece, Full Port with Stainless Steel Trim:
1. Comply with MSS SP-110
  2. SWP Rating: 150 psig.
  3. CWP Rating: 600 psig.
  4. Body: Bronze.
  5. Ends: Threaded.
  6. Seats: PTFE.
  7. Stem: Stainless steel
  8. Ball: Stainless steel, vented

**2.06 STAINLESS STEEL BALL VALVES**

- A Two Piece, Full Port with Stainless Steel Trim:
1. Comply with MSS SP-110
  2. SWP Rating: 150 psig.
  3. CWP Rating: 1000 psig.
  4. Body: Stainless steel
  5. Seats: PTFE
  6. Stem: Stainless steel
  7. Ball: Stainless steel

**2.07 IRON BALL VALVES**

- A Class 125, Full Port, Stainless Steel Trim:
1. Comply with MSS SP-72.
  2. CWP Rating: 200 psig.
  3. Body: ASTM A536 Grade 65-45-12, ductile iron.
  4. Ends: Flanged
  5. Seats: PTFE
  6. Stem: Stainless steel
  7. Ball: Stainless steel
  8. Operator: Lever, with locking handle.

**2.08 IRON, SINGLE FLANGE BUTTERFLY VALVES**

- A Lug type: Bi-directional dead-end service without use of downstream flange.
1. Comply with MSS SP-67, Type I.
  2. CWP Rating: 200 psig.
  3. Body: ASTM A126, cast iron or ASTM A536, ductile iron.
  4. Stem: One or two-piece stainless steel.
  5. Seat: EPDM
  6. Disc: Stainless steel

**2.09 IRON, GROOVED-END BUTTERFLY VALVES**

- A CWP Rating: 175 psig (1200 kPa).
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

**2.10 BRONZE LIFT CHECK VALVES**

- A Class 125:

1. Comply with MSS SP-80, Type 1, Metal Disc to Metal Seat and Type 2, Nonmetallic Disc to Metal Seat.
2. CWP Rating: 200 psig.
3. Design: Vertical flow
4. Body: Comply with ASTM B61 or ASTM B62, bronze
5. Ends: Threaded as indicated
6. Disc (Type 1): Bronze.

#### 2.11 BRONZE SWING CHECK VALVES

A Class 125: CWP Rating: 200 psig (1380 kPa).

1. Comply with MSS SP-80, Type 3
2. Design: Horizontal flow
3. Body: Bronze, ASTM B62
4. Ends: Threaded as indicated
5. Disc: Bronze

#### 2.12 IRON SWING CHECK VALVES

A Class 125:

1. Comply with MSS SP-71, Type I.
2. CWP Rating: 200 psig.
3. Design: Clear or full waterway.
4. Body: ASTM A126, gray iron with bolted bonnet.
5. Ends: Flanged as indicated.
6. Trim: Composition.
7. Seat Ring and Disc Holder: Bronze.
8. Disc: PTFE or \_\_\_\_.
9. Gasket: Asbestos free.

B Class 250:

1. Comply with MSS SP-71, Type I.
2. CWP Rating: 500 psig.
3. Design: Clear or full waterway.
4. Body: ASTM A126, gray iron with bolted bonnet.
5. Ends: Flanged as indicated
6. Trim: Bronze
7. Metal Seat
8. Gasket: Asbestos free

#### 2.13 IRON GROOVED-END SWING CHECK VALVES

A 300 CWP:

1. CWP Rating: 300 psig.
2. Body: ASTM A536, Grade 65-45-12 ductile iron.
3. Seal: EPDM
4. Disc: Stainless steel
5. Coating: Black, non-lead paint

#### 2.14 IRON CENTER-GUIDED CHECK VALVES

A Class 125, Compact-Wafer:

1. Comply with MSS SP-125.
2. CWP Rating: 200 psig.
3. Body: 316 stainless steel.
4. Metal Seat: Stainless steel.

B Class 125, Globe:

1. Comply with MSS SP-125.
2. CWP Rating: 200 psig.
3. Body: Stainless steel.
4. Style: Spring loaded.

5. Ends: Flanged.
  6. Metal Seat: Stainless steel.
- C Class 150, Compact-Wafer:
1. Comply with MSS SP-125.
  2. CW P Rating: 300 psig.
  3. Body: 316 Stainless steel.
  4. Metal Seat: Stainless steel.
- D Class 150, Globe:
1. Comply with MSS SP-125.
  2. CWP Rating: 300 psig.
  3. Body: Stainless steel.
  4. Style: Spring loaded.
  5. Ends: Flanged.
  6. Metal Seat: Stainless steel.

## 2.15 IRON PLATE TYPE CHECK VALVES

- A Class 125 Single-Plate:
1. Comply with API STD 594.
  2. CWP Rating: 200 psig.
  3. Design: Wafer, spring-loaded plate.
  4. Body: ASTM A126, gray iron.
  5. Resilient Seat: EPDM.
- B Class 125, Dual-Plate:
1. Comply with API STD 594.
  2. CWP Rating: 200 psig.
  3. Design: Wafer, spring-loaded plates.
  4. Body: ASTM A126, gray iron.
  5. Resilient Seat: EPDM.
- C Class 150, Dual-Plate:
1. Comply with API STD 594.
  2. CWP Rating: 300 psig.
  3. Design: Wafer, spring-loaded plates.
  4. Body: ASTM A395/A395M or ASTM A536, ductile iron.
  5. Resilient Seat: EPDM.
- D Class 250, Single-Plate:
1. Comply with API STD 594.
  2. CWP Rating: 400 psig.
  3. Design: Wafer, spring-loaded plate.
  4. Body: ASTM A126, gray iron.
  5. Resilient Seat: EPDM.

## 2.16 BRONZE GLOBE VALVES

- A Class 125: CWP Rating: 200 psig; and Class 150: CWP Rating: 300 psig:.
1. Comply with MSS SP-80, Type 1.
  2. Body: ASTM B62, bronze with integral seat and screw-in bonnet.
  3. Ends: Threaded or solder joint
  4. Stem: Bronze
  5. Disc: Bronze
  6. Packing: Asbestos free
  7. Handwheel: Bronze or aluminum

## 2.17 IRON GLOBE VALVES

- A Class 125: CWP Rating: 200 psig:.
1. Comply with MSS SP-85, Type I.
  2. Body: Gray iron; ASTM A126, with bolted bonnet

3. Ends: Flanged
4. Trim: Bronze
5. Packing and Gasket: Asbestos free
6. Operator: Handwheel or chainwheel

### **2.18 STAINLESS STEEL GLOBE VALVES**

- A Class 150: CWP Rating: 300 psig:
1. Comply with ASME B16.34 for pressure-temperature range.
  2. Body: 316L stainless steel, with bolted bonnet.
  3. Ends: Flanged.
  4. Trim: Stainless steel.
  5. Packing and Gasket: Asbestos free.
  6. Operator: Handwheel.

### **2.19 LUBRICATED PLUG VALVES**

- A Regular Gland and Cylindrical with Threaded Ends:
1. Comply with MSS SP-78, Type II.
  2. Class 125: CWP Rating: 200 psig.
  3. Class 250: CWP Rating: 400 psig.
  4. Body: ASTM A48/A48M or ASTM A126, cast iron with lubrication sealing system.
  5. Pattern: Regular or short.
  6. Plug: Cast iron or bronze with sealant groove.

## **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 is 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 Where valve support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.
- D Provide the Owner with a valve chart indicating location, valve number, size, manufacturer, purpose, etc. Frame valve chart under glass.
- E Provide brass or stainless steel valve tags on all valves. Refer to Identification for Plumbing Piping and Equipment Specification for further information.
- F Provide access panel, minimum 18" square, where valves are located above gypsum board ceiling. Access panel shall have fire rating to match ceiling rating, if ceiling is rated. Access panel shall be painted to match ceiling.
- G Provide dot on ceiling grid where valves are located above lay-in ceiling. Refer to Identification for Plumbing Piping and Equipment Specification for further information.
- H The Contractor shall set in service all valves to operating conditions as part of his Contract. Where valves with manual settings are required, valves shall be calibrated by plumbing contractor for a balanced flow.
- I All valve stems shall be accessible and in no case shall valve stems be installed below horizontal.
- J All castings used for coupling housings, fittings, valve bodies, etc., shall be date stamped for quality assurance and traceability.
- K In no case shall raised face flanges be bolted to flat face flanges.
- L All flanged connections shall be gasketed.

- M All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.
- N When soldering valves with TFE or PTFE Seats, contractor shall remove valve body to protect seats.
- O All elastomers used for seals and seats shall be UL Classified in accordance with NSF-61/NSF-372 for potable water service
- P Install check valves where necessary to maintain direction of flow as follows:
  1. Lift Check: Install with stem plumb and vertical.
  2. Swing Check: Install horizontal maintaining hinge pin level.
  3. Orient plate-type and center-guided into horizontal or vertical position, between flanges.

**END OF SECTION 22 05 23**

**SECTION 22 05 29**

**HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A Support and attachment components for equipment, piping, and other plumbing work for a completely and properly supported plumbing system.

**1.02 REFERENCE STANDARDS**

- A ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.
- B ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2016a.
- C ASTM A181/A181M - Standard Specification for Carbon Steel Forgings, for General-Purpose Piping; 2022.
- D ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.
- E ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings; 1999, with Editorial Revision (2022).
- F ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2019.
- G ASTM D635 - Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position; 2022.
- H ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2018b.
- I ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2022a, with Editorial Revision (2023).
- J MFMA-4 - Metal Framing Standards Publication; 2004.
- K MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2018, with Amendment (2019).
- L NFPA 101 - Life Safety Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- M UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

**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. Contractor is responsible for reviewing complete construction document package and determining, prior to the start of work, which portions of the above grade structural slabs are hard rock concrete and/or lightweight insulating concrete and shall review the structural engineer's requirements for attachment to slabs. Unistrut or other forms of support required to span multiple joists or beams shall be part of the contractor's bid price. No additional monies will be given for support steel or other members required where piping may not be allowed to be supported by the concrete deck above.
- B Sequencing:
  - 1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section 03 30 00.

**1.04 SUBMITTALS**

- A Product Data: Provide manufacturer's standard catalog pages and data sheets for metal channel (strut) framing systems, non-penetrating rooftop supports, post-installed concrete and masonry anchors, thermal insulated pipe supports, and all devices required for a complete hanger and support system.

- B Approved Manufacturers: Eaton / Cooper B-Line, Thomas & Betts Corporation, nVent Caddy (Erico), Unistrut, or prior Engineer Approved Equal
- C Furnish all support materials, associated fittings, accessories, and hardware produced by a single manufacturer.

#### 1.05 QUALITY ASSURANCE

- A Comply with applicable building code.
- B Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C Installer Qualifications for Powder-Actuated Fasteners (when specified): Certified by fastener system manufacturer with current operator's license.
- D Installer Qualifications for Field-Welding: As specified in Section 05 50 00.
- E Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

#### 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. Comply with MSS SP-58.
  - 2. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of plumbing work.
  - 3. Provide products listed, classified, and labeled as suitable for the 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 the load to be supported. Include consideration for vibration, equipment operation, and shock loads where applicable.
  - 5. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
  - 6. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
    - a. Indoor Dry Locations: Use zinc-plated steel or galvanized steel, or epoxy plated steel 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 Metal Channel (Strut) Framing Systems:
  - 1. Provide 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. Minimum Channel Thickness: Steel sheet, 12 gage, 0.1046 inch.
  - 4. Minimum Channel Dimensions: 1-5/8 inch width by 13/16 inch height.
- C Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.
  - 1. Minimum Size, Unless Otherwise Indicated or Required:
    - a. Equipment Supports: 1/2 inch diameter.
    - b. Piping up to 1 inch (27 mm) nominal: 1/4 inch diameter.
    - c. Piping larger than 1 inch (27 mm) nominal: 3/8 inch diameter.
    - d. Trapeze Support for Multiple Pipes: 3/8 inch diameter.
- D Pipe Supports:
  - 1. 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.
- E Beam Clamps: MSS SP-58 Types 19 through 23, 25 or 27 through 30 based on required load.
  - 1. Material: ASTM A36/A36M carbon steel or ASTM A181/A181M forged steel.

2. Provide clamps with hardened steel cup-point set screws and lock-nuts for anchoring in place.
- F Riser Clamps:
  1. Provide copper plated clamps for copper tubing support.
  2. For insulated pipe runs, provide two bolt-type clamps designed for installation under insulation.
- G Offset Pipe Clamps: Double-leg design two-piece pipe clamp.
- H Strut Clamps: Two-piece pipe clamp.
- I Insulation Clamps: Two bolt-type clamps designed for installation under insulation.
- J Pipe Hangers: For a given pipe run, use hangers of the same type and material.
  1. Material: Malleable iron, ASTM A47/A47M; or carbon steel, ASTM A36/A36M.
  2. Provide coated or plated hangers to isolate steel hangers from dissimilar metal tube or pipe.
- K Intermediate Pipe Guides: Use pipe clamps with oversize pipe sleeve that provides clearance around pipe.
  1. Pipe Diameter 6 inches and Smaller: Provide minimum clearance of 0.16 inch.
  2. Pipe Diameter 8 inches: Provide U-bolts with double nuts providing minimum clearance of 0.28 inch.
  3. Pipe Diameter 8 inches: 0.625 inch U-bolt.
  4. Pipe Diameter 10 inches: 0.75 inch U-bolt.
  5. Pipe Diameter 12 to 16 inches: 0.875 inch U-bolt.
  6. Pipe Diameter 18 to 30 inches: 1 inch U-bolt.
- L 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.
- M Nonpenetrating Rooftop Supports for Low-Slope Roofs:
  1. Provide steel pedestals with thermoplastic or rubber base 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.
  2. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
  3. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports.
  4. Mounting Height: Provide minimum clearance of 6 inches under supported component to top of roofing.
- N Anchors and Fasteners:
  1. Manufacturers - Mechanical Anchors:
    - a. Hilti, Inc
    - b. ITW Red Head, a division of Illinois Tool Works, Inc
    - c. Powers Fasteners, Inc
    - d. Simpson Strong-Tie Company Inc
    - e. nVent CADDY (Erico).
  2. Manufacturers - Powder-Actuated Fastening Systems:
    - a. Hilti, Inc
    - b. ITW Ramset, a division of Illinois Tool Works, Inc
    - c. Powers Fasteners, Inc
    - d. Simpson Strong-Tie Company Inc
  3. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
  4. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
  5. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
  6. Hollow Masonry: Use toggle bolts.
  7. Hollow Stud Walls: Use toggle bolts.
  8. Steel: Use beam clamps, machine bolts, or welded threaded studs.
  9. Sheet Metal: Use sheet metal screws.
  10. Wood: Use wood screws.
  11. Plastic and lead anchors are not permitted.
  12. Powder-actuated fasteners are permitted only as follows:



- a. Where approved by Architect.
- b. Use only threaded studs; do not use pins.
13. Hammer-driven anchors and fasteners are permitted only as follows: Wood Frame Construction
14. 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.
  - c. Minimum Channel Thickness: Steel sheet, 12 gage, 0.1046 inch minimum base metal thickness.
  - d. Manufacturer: Same as manufacturer of metal channel (strut) framing system.
15. Post-Installed Concrete and Masonry Anchors: Evaluated and recognized by ICC Evaluation Service, LLC (ICC-ES) for compliance with applicable building code.

### **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 anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.
- 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 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 4 inch high concrete pad constructed in accordance with Section 03 30 00.
  5. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
- H Preset Concrete Inserts: Use manufacturer-provided closure strips to inhibit concrete seepage during concrete pour.
- I Secure fasteners according to manufacturer's recommended torque settings.
- J Remove temporary supports.
- K The actual arrangement of the piping shall follow the general locations shown on the Drawings, such that clearances, line drainage, etc. shall be maintained.
- L In no case shall this Contractor be allowed to cut or reduce the specified covering to allow the application of a smaller hanger than required.
- M Hangers supporting vertical and horizontal copper piping, sized 1 1/2" in diameter and larger, shall be spaced on not more than 10-foot centers and 30" of each change or direction.
- N Hangers supporting vertical and horizontal copper piping, sized 1 1/4" in diameter and smaller, shall be spaced on not more than 6-foot centers and 30" of each change of direction.
- O Hangers supporting vertical and horizontal PVC piping of any size shall be spaced on not more than 4-foot centers and 30" of each change of direction.

- P Hangers supporting vertical and horizontal CPVC piping 1 ¼" in diameter and larger shall be spaced on not more than 4-foot centers and 30" of each change of direction.
- Q Hangers supporting vertical and horizontal CPVC piping 1" in diameter and smaller shall be spaced on not more than 3-foot centers and 30" of each direction.
- R Hangers supporting horizontal cast iron piping of any size shall be spaced not more than 5-foot centers and 30" of each change of direction, with a minimum of two hangers per section.
- S Hangers supporting vertical cast iron piping of any size shall be spaced on not more than 10-foot centers and 30" of each change of direction, with a minimum of two hangers per section.
- T Rigid support sway bracing shall be provided at changes in direction greater than 45 degrees for all pipe sizes 4" and larger.
- U Vertical risers shall be supported at each floor, 5-feet on center, and/or at changes in direction of pipe.
- V Sleeves shall be provided wherever pipes pass through walls, floors and ceilings. Sleeves shall be Schedule 40, black steel, ½" in diameter larger than the pipe or insulation on the pipe. Sleeves through walls and ceilings shall be flush. Sleeves through floors shall extend one inch above finished floor. Sleeves in exterior walls shall be caulked and made water-tight.

**3.03 FIELD QUALITY CONTROL**

- A Inspect support and attachment components for damage and defects.
- 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 support and attachment components.

**END OF SECTION 22 05 29**

**SECTION 22 05 53**

**IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

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

**1.02 REFERENCE STANDARDS**

- A ASME A13.1 - Scheme for the Identification of Piping Systems; 2020.
- B ASTM D709 - Standard Specification for Laminated Thermosetting Materials; 2017.

**1.03 SUBMITTALS**

- A List: Submit list of wording, symbols, letter size, and color coding for plumbing identification.
- B Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
- C Product Data: Provide manufacturers catalog literature for each product required.
- D Manufacturer's Installation Instructions: Indicate special procedures, and installation.
- E Project Record Documents: Record actual locations of tagged valves.

**PART 2 PRODUCTS**

**2.01 IDENTIFICATION APPLICATIONS**

- A Control Panels: Nameplates.
- B Heat Transfer Equipment: Nameplates.
- C Major Control Components: Nameplates.
- D Piping: Tags.
- E Pumps: Nameplates.
- F Small-sized Equipment: Tags.
- G Tanks: Nameplates.
- H Valves: Tags and ceiling tacks where located above lay-in ceiling.
- I Water Treatment Devices: Nameplates.

**2.02 NAMEPLATES**

- A Manufacturers:
  - 1. Brimar Industries, Inc.: [www.pipemarker.com](http://www.pipemarker.com).
  - 2. Kolbi Pipe Marker Co.: [www.kolbipipemarkers.com](http://www.kolbipipemarkers.com).
  - 3. Preferred Utilities Mfg. Corp.
  - 4. Seton Identification Products: [www.seton.com](http://www.seton.com).
  - 5. Brady Corporation.
- B Description: Laminated three-layer plastic with black engraved letters on light contrasting background.
  - 1. Letter Color: Black.
  - 2. Letter Height: 1/4 inch.
  - 3. Background Color: light, contrasting background.
  - 4. Plastic: Comply with ASTM D709.

**2.03 TAGS**

- A Manufacturers:
  - 1. Brady Corporation: [www.bradycorp.com](http://www.bradycorp.com).
  - 2. Brimar Industries, Inc.: [www.pipemarker.com](http://www.pipemarker.com).
  - 3. Kolbi Pipe Marker Co.: [www.kolbipipemarkers.com](http://www.kolbipipemarkers.com).
  - 4. Seton Identification Products: [www.seton.com](http://www.seton.com).
- B Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges.
- C Valve Tag Chart: Typewritten letter size list in anodized aluminum frame.

**2.04 PIPE MARKERS**

- A Manufacturers:

1. Brady Corporation: [www.bradycorp.com](http://www.bradycorp.com).
  2. Carlton Industries, Inc.
  3. Brimar Industries, Inc.: [www.pipemarker.com](http://www.pipemarker.com).
  4. Kolbi Pipe Marker Co.: [www.kolbipipemarkers.com](http://www.kolbipipemarkers.com).
  5. Seton Identification Products: [www.seton.com](http://www.seton.com).
- B Comply with ASME A13.1.
- C 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.
- D Color: Standard colors for selected plumbing piping, attached at end of Section.
- E Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.
- F Underground Plastic Pipe Markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service. Message must repeat within a maximum of 40". Printed legend shall be indicative of type of underground line. Underground gas lines shall have insulated copper tracer wire, minimum 18 AWG with insulation suitable for direct burial and ends shall terminate above grade.

## 2.05 CEILING TACKS

- A Manufacturers:
1. Craftmark Pipe Markers; \_\_\_\_\_: [www.craftmarkid.com/#sle](http://www.craftmarkid.com/#sle).
  2. MSI.
  3. Seton.
- B Description: Steel with 3/4 inch diameter color coded head.
- C Install label on ceiling grid in proximity to device above ceiling. Indicate type of device and associated service on label. (e.g. "CW-21"). Next to label, on ceiling grid, provide round dot.
- D Provide custom printed labels, either of vinyl suitable for indoor/outdoor applications or of polypropylene for each device. Utilize portable printer equal to Brady HandiMark Portable Industrial Labeling System.
- E Maximum height of label is one inch. Black lettering on white tape. Font size 18.
- F Color code as follows unless Owner has their own standard - Contractor to verify prior to start of work:
1. Cold Water: Blue dot
  2. Hot Water: Green dot
  3. Hot Water Return: Green dot
  4. All other valves: Black Dot

## PART 3 EXECUTION

### 3.01 PREPARATION

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

### 3.02 INSTALLATION

- A Install plastic 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 All exposed piping in mechanical rooms, boiler rooms, on and above mezzanine levels, both insulated and uninsulated, shall be either painted or color coded using 0.030" PVC jacketing by the Plumbing Contractor and labeled by the Contractor as per the following schedule:
1. Domestic Cold Water: Blue
  2. Domestic Hot Water: Red
  3. Makeup Water: Green
  4. Fuel Gas: Yellow
  5. Non-Potable Water: Purple
- D All non-potable water outlets shall include a phenolic sign with yellow background and black letters 1/2" high stating: "NON-POTABLE WATER – NOT SAFE FOR DRINKING"
- E Install plastic pipe markers in accordance with manufacturer's instructions.
- F Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.
- G Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.

- H 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.
- I Locate ceiling tacks to locate valves or dampers above lay-in panel ceilings. Locate in corner of panel closest to equipment.
- J Identify water heaters, with plastic nameplates. Small devices may be identified with tags.
- K Identify control panels, manual motor starters, combination motor starters, disconnects, emergency shutoff switches, water heater override switches, water heater emergency switches and major control components outside panels with plastic nameplates.
- L Identify aquastats or temperature sensors relating to water heaters or valves with nameplates.
- M Identify valves in main and branch piping with valve tags.
- N Tag automatic controls, instruments, and relays. Key to control schematic.
- O Identify water heaters with plastic nameplates indicating unit number and area served.
- P Identify pumps with plastic nameplates indicating pump number and system served.

### 3.03 SCHEDULES

- A Standard Color Identification for Plumbing Piping unless Owner has their own standard - Contractor to verify prior to start of work (all labels shall be provided with flow arrows):
  - 1. Domestic Cold Water: White Lettering/Green Background
  - 2. Domestic Hot Water: Black Lettering/Yellow Background
  - 3. Domestic Hot Water Return: Black Lettering/Yellow Background
  - 4. Fuel Gas Piping: Black Lettering/Yellow Background
  - 5. Fuel Oil Piping: Black Lettering/Yellow Background
  - 6. Compressed Air: White Lettering/Blue Background
  - 7. Roof Drain: Black Lettering/White Background
  - 8. Overflow Roof Drain: Black Lettering/White Background
  - 9. Condensate Drain: Black Lettering/White Background
  - 10. Non-Potable Water: Black Lettering/Yellow Background
- B All medical gas piping shall conform to NFPA 99 marking standards.

**END OF SECTION 22 05 53**

**SECTION 22 05 70**  
**PLUMBING COORDINATION DRAWINGS**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A The Plumbing Contractor shall be responsible for providing ¼ scale coordination drawings for the entire project, format shall be as stated below.
- B The drawings shall cover above ceiling space, mechanical rooms, electrical rooms and service yards.

**PART 2 EXECUTION**

**2.01 COORDINATION (REVIT)**

- A The Plumbing Contractor shall obtain the architectural, structural, and MEP REVIT models from the Architect. The models will be in REVIT 2020.
- B The Plumbing Contractor shall produce drawings that indicate all piping, including underground piping, and equipment on ¼ scale drawings. All items shall be drawn to scale, dimensioned and be easily identified. The drawings shall indicate a bottom of pipe.
- C The Plumbing Contractor shall provide the Mechanical Contractor a file compatible with Navisworks that indicates all piping and plumbing equipment.
- D The overall coordination drawings shall be completed prior to any plumbing, mechanical and electrical work beginning. Start of work, including underground work, without completed Coordination Drawings is at the Contractor's risk.

**END OF SECTION 22 05 70 22 05 70**

**SECTION 22 07 19**  
**PLUMBING PIPING INSULATION**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A Flexible elastomeric cellular insulation.
- B Glass fiber insulation.
- C Jacketing and accessories.

**1.02 REFERENCE STANDARDS**

- A ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement; 2007 (Reapproved 2019).
- B ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2023.
- C ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation; 2022a.
- D ASTM C552 - Standard Specification for Cellular Glass Thermal Insulation; 2022.
- E ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications; 2013 (Reapproved 2019).
- F ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation; 2022.
- G ASTM C585 - Standard Practice for Inner and Outer Diameters of Thermal Insulation for Nominal Sizes of Pipe and Tubing; 2022.
- H ASTM C591 - Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation; 2022.
- I ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel; 2008 (Reapproved 2018).
- J ASTM D1056 - Standard Specification for Flexible Cellular Materials—Sponge or Expanded Rubber; 2020.
- K ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2018b.
- L ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2022a, with Editorial Revision (2023).
- M UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

**1.03 SUBMITTALS**

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

**1.04 QUALITY ASSURANCE**

- A Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than three years of documented experience.
- B Applicator Qualifications: Company specializing in performing the type of work specified in this section with minimum three years of experience.

**1.05 DELIVERY, STORAGE, AND HANDLING**

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

**1.06 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/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723

**2.02 GLASS FIBER INSULATION**

- A Manufacturers:
  - 1. CertainTeed Corporation
  - 2. Johns Manville Corporation
  - 3. Knauf Insulation; Earthwool 1000 Degree Pipe Insulation
  - 4. Owens Corning Corporation

- B Insulation: ASTM C547 and ASTM C795; rigid molded, noncombustible.
  - 1. K Value: ASTM C177, 0.24 at 75 degrees F.
  - 2. Maximum Service Temperature: 850 degrees F.
  - 3. Maximum Moisture Absorption: 0.2 percent by volume.
- C Insulation: ASTM C547 and ASTM C795; rigid molded, noncombustible, with wicking material to transport condensed water to the outside of the system for evaporation to the atmosphere.
  - 1. K Value: ASTM C177, 0.23 at 75 degrees F.
  - 2. Maximum Service Temperature: 220 degrees F.
  - 3. Maximum Moisture Absorption: 0.2 percent by volume.
- D 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.
- E 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 inch.
- F Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.
- G Vapor Barrier Lap Adhesive: Compatible with insulation.
- H Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.
- I Indoor Vapor Barrier Finish:
  - 1. Cloth: Untreated; 9 oz/sq yd weight.
- J Outdoor Vapor Barrier Mastic: Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.

### **2.03 FLEXIBLE ELASTOMERIC CELLULAR INSULATION**

- A Manufacturers:
  - 1. Aeroflex USA, Inc: [www.aeroflexusa.com](http://www.aeroflexusa.com).
  - 2. Armacell LLC: [www.armacell.us](http://www.armacell.us).
  - 3. K-Flex USA LLC: [www.kflexusa.com](http://www.kflexusa.com).
- B Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1; use molded tubular material wherever possible.
  - 1. Minimum Service Temperature: Minus 40 degrees F.
  - 2. Maximum Service Temperature: 220 degrees F.
  - 3. Connection: Waterproof vapor barrier adhesive.
- C Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

### **2.04 JACKETING AND ACCESSORIES**

- A Canvas Jacket: UL listed 6 oz/sq yd plain weave cotton fabric treated with dilute fire retardant lagging adhesive. (INTERIOR)
  - 1. Lagging Adhesive: Compatible with insulation.
- B Aluminum Jacket: ASTM B209 (ASTM B209M) formed aluminum sheet. (EXTERIOR)
  - 1. Thickness: 0.016 inch sheet.
  - 2. Finish: Smooth.
  - 3. Joining: Longitudinal slip joints and 2 inch laps.
  - 4. Fittings: 0.016 inch thick die-shaped fitting covers with factory-attached protective liner.
  - 5. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A Verify that piping has been tested before 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 North American Insulation Manufacturers Association (NAIMA) National Insulation Standards.



- C All valve handles on insulated piping shall be extended beyond the surface of the insulation using approved listed valve stem handle extensions made by same manufacturer of the valves.
- D Exposed Piping in Mechanical Spaces and Exposed to Public View Piping (open ceiling): Shall be covered with eight-ounce canvas jacket, pasted in place and glue sized twice for painting - locate insulation and cover seams in least visible locations. Canvas shall be coated twice with Foster fireproof lagging to assure flame and smoke spread ratings. Coordinate sequencing with painting schedule and finishes - refer to architecture documents for painting requirements at Open-to-View ceilings.
- E All waste piping above slab carrying cold condensate, for instance roof drain piping carrying cold condensate from rooftop mechanical units, including traps and floor drain bodies, except in a crawl space, shall be fully insulated as specified herein within the thermal envelope.
- F All horizontal storm drain piping above slab on grade and all vertical risers up to, and including, elbows and roof drain bodies, shall be fully insulated as specified herein.
- G Closed cell insulation, may be used in lieu of fiberglass on all water pipes - especially in block walls. All Closed cell insulation shall be jacketed with canvas jacketing prior to being painted and shall be jacketed with Prefroemd PVC Covers when exposed to view.
- H Insulation shall be finished with a fire retardant coating to attain proper fire rating.
- I Glass fiber insulated pipes conveying fluids below ambient temperature:
  - 1. Provide vapor barrier jackets, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure-sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.
  - 2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive or PVC fitting covers.
- J Glass fiber insulated pipes conveying fluids above ambient temperature:
  - 1. Provide standard jackets, with vapor barrier, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples.
  - 2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
- K Inserts and Shields:
  - 1. Application: Piping 1-1/2 inches diameter or larger.
  - 2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
  - 3. Insert Location: Between support shield and piping and under the finish jacket.
  - 4. Insert Configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
  - 5. Insert Material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.
- L Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. Refer to referenced Rated Partition and/or Floor Penetration UL Details and Non-Rated Partition and/or Floor Penetration Details in the drawings where applicable.
- M All insulation shall be finished with a fire retardant coating to attain proper fire rating.
- N Closed cell insulation shall be installed in strict accordance with the manufacturer's installation instructions.
- O Insulate fittings with pre-fabricated PVC fitting covers.
- P Exterior Applications: Provide vapor barrier jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Cover with aluminum jacket with seams located on bottom side of horizontal piping.
- Q Buried Piping: Provide factory fabricated assembly with inner all-purpose service jacket with self-sealing lap, and asphalt impregnated open mesh glass fabric, with one mil, 0.001 inch thick aluminum foil sandwiched between three layers of bituminous compound; outer surface faced with a polyester film.
- R Heat Traced Piping: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer. Cover with aluminum jacket with seams located on bottom side of horizontal piping.

**3.03 SCHEDULES**

**A Plumbing Systems:**

1. Domestic Hot Water Supply:
  - a. Glass Fiber Insulation:
    - 1) Pipe Size Range: 0-6 inch.
    - 2) Thickness: 1 inch.
  - b. Cellular Foam Insulation:
    - 1) Pipe Size Range: 0-6 inch.
    - 2) Thickness: 1 inch.
2. Domestic Hot Water Recirculation:
  - a. Glass Fiber Insulation:
    - 1) Pipe Size Range: All sizes.
    - 2) Thickness: 1 inch.
  - b. Polyurethane Foam Insulation:
    - 1) Pipe Size Range: All sizes.
    - 2) Thickness: 1/2 inch.
3. Tempered Domestic Water Supply:
  - a. Same as Domestic Hot Water Supply
4. Domestic Cold Water:
  - a. Glass Fiber Insulation:
    - 1) Pipe Size Range: All sizes
    - 2) Thickness: 1/2 inch
    - 3) Thickness: 1 inch (WCPSS)
  - b. Closed Cell Insulation:
    - 1) Pipe Size Range: All sizes
    - 2) Thickness: 1/2 inch
    - 3) Thickness: 1 inch (WCPSS)
5. Roof Drain Bodies:
  - a. Glass Fiber Insulation:
    - 1) Thickness: 1 inch
6. Roof Drainage Above Grade:
  - a. Glass Fiber Insulation:
    - 1) Thickness: 1 inch
7. Mechanical Condensate, including traps and floor drain bodies:
  - a. Glass Fiber Insulation:
    - 1) Pipe Size Range: All sizes.
    - 2) Thickness: 1 inch.

**END OF SECTION 22 07 19**

**SECTION 22 08 00**  
**PLUMBING COMMISSIONING REQUIREMENTS**

**PART 1 - GENERAL**

**1.01 DESCRIPTION**

- A Commissioning
  1. Commissioning is a systematic process of ensuring that all building systems perform interactively according to the owner's project requirements and operational needs. The commissioning process shall encompass and coordinate the traditionally separate functions of system documentation, equipment startup, performance testing and training. Commissioning during the construction phase is intended to achieve the following specific objectives:
  2. Verify that applicable equipment and systems are installed according to the manufacturer's recommendations and to industry accepted minimum standards and that they receive adequate operational checkout by installing contractors.
  3. Verify and document proper functional performance of equipment and systems.
  4. Verify that O&M documentation is complete.
  5. Verify that the Owner's operating personnel are adequately trained.

**1.02 RELATED WORK**

- A Section 01 1000 – Summary of Work
- B Section 01 3300 – Submittal Procedures
- C Section 01 7700 – Closeout Procedures
- D Section 01 7823 – Operation and Maintenance Data
- E Section 01 7839 – Project Record Document
- F Section 01 7900 – Demonstration and Training
- G Section 01 9113 – General Commissioning Requirements
- H Division 22 - Plumbing

**1.03 ABBREVIATIONS AND DEFINITIONS**

- A A/E: Architect, Architect/Engineer, and/or Engineer
- B ASI: Architectural Supplemental Instruction
- C BAS: Building Automation System
- D BoD: Basis of Design. A narrative of how the designer plans to achieve the OPR
- E CxA: Commissioning Authority
- F Controls Contractor
- G CM: Construction Manager
- H Cx: Commissioning
- I Cx Plan: Commissioning Plan
- J Cx RFI: Commissioning Request for Information
- K DDC: Direct Digital Control System
- L Deficiency: A condition in the installation or function of a component, piece of equipment or system that is not in compliance with the Contract Documents and cannot be corrected in five (5) minutes time.
- M EC: Electrical Contractor
- N FBO: Furnished By Others
- O FT: Functional Performance Test
- P IAW: In Accordance With
- Q MC: Mechanical Contractor
- R O&M: Operation and Maintenance
- S OPM: Owner Project Manager
- T OPR: Owner Project Requirement. A dynamic document expressing how the owner expects the building systems to perform upon project completion.
- U PC: Prefunctional Checklist
- V RFI: Request for Information
- W Sub(s): Subcontractors or Prime Contractor
- X TC: Testing Contractor

Y TBD: To Be Determined

#### 1.04 PLUMBING SYSTEMS TO BE COMMISSIONED

- A Domestic hot water systems
- B Natural gas supply equipment
- C Sump pumps and sump pump controls

#### 1.05 SUBMITTALS

- A Refer also to Specification Section 01 9113, Subsection 1.6.
- B Provide the CxA a copy of the following items, for the systems to be commissioned:
  - 1. Equipment and System Submittals to include, at minimum, the following:
    - a. Cut Sheets
    - b. Performance data
    - c. Manufacturer's pre-startup checklists
      - 1) Manufacturer's start-up checklists
      - 2) Installation Instructions
    - d. Shop drawings (including any resubmittals required by the A/E)
    - e. Test plan
    - f. Completed field test report, including all completed forms and checklist; and list of all outstanding deficiencies and uncompleted items
    - g. Operational and maintenance documentation
    - h. Training plan and training materials
    - i. As-built documentation

### PART 2 - PRODUCTS

#### 2.01 TEST EQUIPMENT

- A Refer to Specification Section 01 9113, Subsection 2.1.
- B Instrumentation required to verify readings and test system and equipment performance shall be provided by Contractor and made available to Commissioning Authority. Camera equipment capable of viewing an entire pipe assembly at one time.

#### 2.02 CX WEB-BASED COMMISSIONING TOOL

- A Refer to Specification Section 01 9113, Subsection 2.1.

### PART 3 - EXECUTION

#### 3.01 MEETINGS

- A Refer to Specification Section 01 9113, Subsection 3.3.

#### 3.02 START-UP, PREFUNCTIONAL CHECKLISTS AND INITIAL CHECKOUT

- A The following procedures apply to all equipment to be commissioned, according to Section 1.4 above.
- B General
  - 1. Contractor shall complete plumbing testing as required in sections 22 1118, 22 1314, and 22 3314.
  - 2. Testing Plan
    - a. The subcontractor responsible for providing and installing the equipment completes the testing plan. The test plan will include checklists and procedures with specific boxes or lines for recording and documenting the tests, and a summary statement with a signature block at the end of the plan.
    - b. The contractor submits the full test plan to the A/E and CxA for review and approval.
  - 3. Execution of Testing Plan
    - a. Two weeks prior to testing, the Subs and vendors schedule testing with the OPM, CM and CxA. The performance of the tests are directed and executed by the Sub or vendor.
    - b. The CxA and possibly the A/E will observe the testing procedures for selected pieces of equipment.
    - c. The Subs and vendors shall execute testing and provide the CM with a signed and dated copy of the completed testing report. The CM reviews for completion and accuracy, then submits to the CxA and A/E.
    - d. Only individuals that have direct knowledge and witnessed that a line item task on the testing was actually performed shall initial or check that item off. It is not acceptable for witnessing

supervisors to fill out these forms.

4. Deficiencies, Non-Conformance and Approval in Checklists and Startup
  - a. The Sub(s) shall clearly list any outstanding items of the initial testing that were not completed successfully. The testing forms and any outstanding deficiencies shall be provided to the CxA within two days of test completion.
  - b. The installing Subs or vendors shall correct all areas that are deficient or incomplete in the tests in a timely manner, and shall notify the CxA as soon as outstanding items have been corrected.
  - c. Items left incomplete, which later cause deficiencies or delays during functional performance testing may result in backcharges to the responsible party. Refer to Section 01 9113, 3.7 – Documentation, Non-Conformance and Approval of Tests.

### **3.03 FUNCTIONAL PERFORMANCE TESTING, VERIFICATION AND VALIDATION**

#### **A Objectives and Scope**

1. The contractor will perform functional performance testing of the water heating equipment and any plumbing automation system integration with the EMS.
2. The objective is to demonstrate that each system is operating according to the owner's project requirements, documented project program, and Contract Documents. Additionally, during the testing process, areas of deficient performance are identified and corrected, improving the operation and function of the systems.
3. The CxA develops specific functional test procedures and forms to verify and document proper operation of each piece of equipment and system. The CxA provides a copy of the test procedures to the A/E, OPM and installing Sub who shall review the tests prior to testing. The A/E and Sub(s) shall point out to the CxA any specific problems as related to feasibility, safety, equipment and warranty protection.
4. Testing proceeds from components to subsystems to systems. When the proper performance of all interacting individual systems has been achieved, the interface or coordinated responses between systems is checked.
5. The contractor shall supply all personnel and equipment for the demonstration, including, but not limited to, tools, instruments, ladders, lifts, computers, software, cables, etc. Contractor supplied personnel must be competent with and knowledgeable of all project-specific systems. All training documentation, submittals, installation manuals, and O&Ms, shall be at the job site before demonstration testing commences.
6. Coordination and Scheduling
  - a. The CM shall provide sufficient notice to the CxA regarding the Subs completion schedule for the testing of all equipment and systems. The CxA will schedule demonstration and validation after written notification from the CM and affected Subs. The CxA shall direct, witness and document the demonstration retesting of equipment and systems. The Subs shall execute the tests.
  - b. In general, functional performance testing shall not be scheduled until all equipment submittals are approved, testing plans are approved, testing has been satisfactorily completed, and testing report has been provided. Scheduling of testing shall be done with a minimum of two weeks notice prior to testing. Testing which occurs outside the presence of the CxA or OPM without written authorization to do so will be required to be re-tested at no expense to the owner.
7. Problem Solving
8. The CxA will recommend solutions to problems found, however the burden of responsibility to solve, correct and retest problems is with the CM, Subs and A/E.

### **3.04 DOCUMENTATION, NON-CONFORMANCE AND APPROVAL OF TESTS**

A Refer to Specification Section 01 9113, Subsection 3.7.

### **3.05 OPERATION AND MAINTENANCE MANUALS**

A In addition to installation manuals, the contractor shall provide one copy of the Operation and Maintenance Manuals to the CxA for the systems to be commissioned. The O&M Manuals shall be provided to the CxA at least 8 weeks prior to the start of Functional Testing. O&M Manuals shall be in electronic form, the file format shall be Adobe Acrobat readable document. The document shall be formatted to include level 1 bookmarks that link to each main section of equipment. Refer to specification section 01 9113, subsection

3.8 for further detail.

**3.06 TRAINING OF OWNER PERSONNEL**

- A See Specification Section 01 9113, Subsection 3.9.
- B Provide designated Owner personnel with comprehensive training in the understanding of the systems and the operation and maintenance of cabling systems.
- C Training shall start with classroom sessions, if necessary, followed by hands-on training on each piece of equipment.

**3.07 DEFERRED TESTING**

- A See Specification Section 01 9113, Subsection 3.10.

**END OF SECTION 22 08 00**

**SECTION 22 10 05**  
**PLUMBING PIPING**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A Pipe, pipe fittings, specialties, and connections for piping systems.
  - 1. Sanitary Sewer Drain, Waste and Vent Pipe and Fittings
  - 2. Lead-Free Domestic Water Pipe and Fittings
  - 3. Stormwater Drain Pipe and Fittings
  - 4. Condensate Drain Pipe and Fittings
  - 5. Natural or LP Gas Pipe and Fittings
  - 6. Flanges, unions, and couplings
  - 7. Manufactured sleeve-seal systems
  - 8. Water pressure reducing valves
  - 9. Relief valves
  - 10. Strainers

**1.02 REFERENCE STANDARDS**

- A ANSI Z21.22 - American National Standard for Relief Valves for Hot Water Supply Systems; 2015 (Reaffirmed 2020).
- B ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; 2021.
- C ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2021.
- D ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2021.
- E ASME B31.1 - Power Piping; 2022.
- F ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators; 2023.
- G ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2022.
- H ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings; 2021.
- I ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.
- J ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2023.
- K ASTM B32 - Standard Specification for Solder Metal; 2020.
- L ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2022.
- M ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2020.
- N ASTM B813 - Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube; 2016.
- O ASTM B828 - Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings; 2016.
- P ASTM C564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings; 2020a.
- Q ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120; 2021a.
- R ASTM D2241 - Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series); 2020.
- S ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40; 2021.
- T ASTM D2513 - Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings; 2020.
- U ASTM D2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems; 2020.
- V ASTM D2665 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings; 2020.
- W ASTM D2846/D2846M - Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Hot- and Cold-Water Distribution Systems; 2019a.

- X ASTM D2855 - Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets; 2020.
- Y ASTM D3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings; 2021.
- Z ASTM F493 - Standard Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings; 2022.
- AA ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers; 2024.
- BB ASTM F876 - Standard Specification for Crosslinked Polyethylene (PEX) Tubing; 2023.
- CC ASTM F877 - Standard Specification for Crosslinked Polyethylene (PEX) Hot- and Cold-Water Distribution Systems; 2023.
- DD ASTM F1960 - Standard Specification for Cold Expansion Fittings with PEX Reinforcing Rings for Use with Cross-Linked Polyethylene (PEX) and Polyethylene of Raised Temperature (PE-RT) Tubing; 2023a.
- EE AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Pipe Systems; 2018.
- FF AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast; 2017, with Errata (2018).
- GG CISPI 301 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications; 2021.
- HH NSF 61 - Drinking Water System Components - Health Effects; 2022, with Errata.
- II NSF 372 - Drinking Water System Components - Lead Content; 2022.

### **1.03 SUBMITTALS**

- A Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.
- B Welder Certificate: Include welders certification of compliance with ASME BPVC-IX.
- C Project Record Documents: Record actual locations of valves.
- D Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
  - 1. Valve Repacking Kits: One for each type and size of valve.

### **1.04 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.
- E Identify pipe with marking including size, ASTM material classification, ASTM specification, potable water certification, water pressure rating.
- F All wetted components of system shall comply with United States Safe Drinking Water Act (Sec.1417) amended 1-4-2011.

### **1.05 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.

### **1.06 FIELD CONDITIONS**

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

## **PART 2 PRODUCTS**

### **2.01 GENERAL REQUIREMENTS**

- A Potable Water Supply Systems: Provide piping, pipe fittings, and solder and flux (if used), that comply with NSF 61 and NSF 372 for maximum lead content; label pipe and fittings.
- B Pipe Bedding - PVC Piping to be bedded in the ground shall be installed according to the requirements and recommendations in ASTM-D2321 and shall be backfilled with Soils meeting the Soils Class III unless otherwise approved by the engineer of record prior to installation. PVC Piping less than 8" in diameter shall be backfilled with material with a maximum aggregate size of 10% of the diameter of the pipe being covered.



**2.02 SANITARY SEWER PIPING, BURIED WITHIN 5 FEET OF BUILDING**

- A Cast Iron Pipe: ASTM A74 extra heavy weight.
  - 1. Fittings: Cast iron.
  - 2. Joints: Hub-and-spigot, CISPI HSN compression type with ASTM C564 neoprene gaskets or lead and oakum.
  - 3. Pipe and Fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute (CISPI) and shall be listed with NSF International.
- B PVC Pipe: ASTM D2665 or ASTM D3034.
  - 1. Fittings: PVC.
  - 2. Joints: Solvent welded, with ASTM D2564 solvent cement.
  - 3. Foam Core PVC Piping is not allowed.

**2.03 SANITARY SEWER PIPING, ABOVE GRADE**

- A Cast Iron Pipe: CISPI 301, hubless, service weight.
  - 1. Fittings: Cast iron.
  - 2. Joints: CISPI 310, neoprene gaskets and stainless steel clamp-and-shield assemblies. Heavy-Duty (4-band) type only.
  - 3. Pipe and Fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute (CISPI) and shall be listed with NSF International.
- B PVC Pipe: ASTM D1785 Schedule 40, or ASTM D2241 SDR 26 with not less than 150 psi pressure rating.
  - 1. Fittings: ASTM D2466, PVC.
  - 2. Joints: Solvent welded, with ASTM D2564 solvent cement.
  - 3. Foam Core PVC Piping is not allowed.

**2.04 DOMESTIC WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING**

- A Piping larger than 2 inch: Ductile Iron Pipe: AWWA C151/A21.51.
  - 1. Fittings: Ductile or gray iron, standard thickness.
  - 2. Joints: AWWA C111/A21.11, styrene butadiene rubber (SBR) or vulcanized SBR gasket with 3/4 inch diameter rods.
- B Piping 2 inch and smaller: Type K copper, soft drawn
  - 1. ASTM B88 (ASTM B88M)
  - 2. Fittings: ASME B16.22, wrought copper and bronze.
  - 3. Use silver solder on all joints underground.

**2.05 DOMESTIC WATER PIPING, ABOVE GRADE**

- A Copper Tube: ASTM B88 (ASTM B88M), Type L (B), Drawn (H).
  - 1. Fittings: ASME B16.22, wrought copper and bronze.
  - 2. Use 95-5 solder (95% tin - 5% antimony) on all water piping joints smaller than 2". Use silver solder on piping 2" and larger and on all joints underground.
  - 3. Joints: Grooved mechanical couplings on piping 3" and larger is acceptable
  - 4. Mechanical Press Sealed Fittings: Double-pressed type, NSF 61 and NSF 372 approved or certified, utilizing EPDM, nontoxic, synthetic rubber sealing elements.
    - a. Manufacturers:
      - 1) Apollo Valves
      - 2) Grinnell Products
      - 3) Viega LLC
      - 4) Nibco.

**2.06 STORM WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING**

- A Cast Iron Pipe: ASTM A74 extra heavy weight.
  - 1. Fittings: Cast iron.
  - 2. Joint Seals: ASTM C564 neoprene gaskets, or lead and oakum.
- B PVC Pipe: ASTM D2665 or ASTM D3034.
  - 1. Fittings: PVC.
  - 2. Joints: Solvent welded, with ASTM D2564 solvent cement.

**2.07 STORM WATER PIPING, ABOVE GRADE**

- A Cast Iron Pipe: CISPI 301, hubless, service weight.
  - 1. Fittings: Cast iron.
  - 2. Joints: Neoprene gaskets and stainless steel clamp-and-shield assemblies.
- B PVC Pipe: ASTM D2665 or ASTM D3034.
  - 1. Fittings: PVC.
  - 2. Joints: Solvent welded, with ASTM D2564 solvent cement.

**2.08 CONDENSATE PIPING**

- A Copper Tube: ASTM B88 (ASTM B88M), Type L (B), Drawn (H).
  - 1. Fittings: ASME B16.22, wrought copper and bronze.
- B Cast Iron Pipe: CISPI 301, hubless, service weight.
  - 1. Fittings: Cast iron.
  - 2. Joints: CISPI 310, neoprene gaskets and stainless steel clamp-and-shield assemblies. Heavy-Duty (4-band) type only.

**2.09 NATURAL GAS PIPING, BURIED BEYOND 5 FEET OF BUILDING**

**2.10 NATURAL GAS PIPING, BURIED WITHIN 5 FEET OF BUILDING**

- A Steel Pipe: ASTM A53/A53M Schedule 40 black.
  - 1. Fittings: ASTM A234/A234M, wrought steel welding type.
  - 2. Joints: ASME B31.1, welded.
  - 3. Jacket: AWWA C105/A21.5 polyethylene jacket or double layer, half-lapped 10 mil polyethylene tape.

**2.11 NATURAL GAS PIPING, ABOVE GRADE**

- A Steel Pipe: ASTM A53/A53M 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.

**2.12 FLANGES, UNIONS, AND COUPLINGS**

- A No-Hub Couplings:
  - 1. Gasket Material: Neoprene complying with ASTM C564.
  - 2. Band Material: Stainless steel.
  - 3. Eyelet Material: Stainless steel.
  - 4. Must meet CISPI 310 and shall be listed by NSF International.
  - 5. NOTE: Transition fittings from Cast Iron piping to PVC Piping must be FM Approved PVC Transition Fitting specifically designed for transition from Cast Iron to PVC - "Band" type transition fittings are not approved.

**2.13 MANUFACTURED SLEEVE-SEAL SYSTEMS**

- A Manufacturers:
  - 1. The Metraflex Company
  - 2. Approved Equal
- B Modular/Mechanical Seal:
  - 1. Synthetic rubber interlocking links continuously fill annular space between pipe and wall/casing opening.
  - 2. Provide watertight seal between pipe and wall/casing opening.
  - 3. Elastomer element size and material in accordance with manufacturer's recommendations.
  - 4. Glass reinforced plastic pressure end plates.

**2.14 PIPING SPECIALTIES**

- A Thermostatic Flow Controls (Replacing Circuit Setters): Thermostatic, self-actuating balancing valve that automatically and continuously adjusts the flow of domestic hot water recirculation systems to maintain a specified temperature at the end of each branch.
  - 1. Manufacturers:
    - a. Circuit Solver
    - b. Acorn
    - c. Approved Equal

2. Construction: Class 125, Brass or bronze body with union on inlet and outlet, temperature and pressure test plug on inlet and outlet, blowdown/backflush drain
3. Calibration: Device Control flow within 5 percent of selected rating, over operating pressure range of 10 times minimum pressure required for control, maximum minimum pressure 3.5 psi.
4. Installation / TAB: During the initial start-up of the Domestic Hot Water System (DHWS), the valve shall be set to wide open and will begin to close once the system temperature requirements are met. System shall be placed into operation and time given for the valves to make the necessary adjustments. BAS Control of Recirculation Pump on and off will not allow the system to properly balance - The specified Aquastat shall be allowed to run Pump On and Off for proper balancing.

## 2.15 WATER PRESSURE REDUCING VALVES

- A Manufacturers:
1. Amtrol Inc
  2. Apollo Valves
  3. Watts Regulator Company
  4. Victaulic Series 386 Pressure Reducing Valve Stations

## 2.16 RELIEF VALVES

## 2.17 STRAINERS

### 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 Testing of all piping under this contract shall be made in the presence of the Engineer or a designated representative of the Owner. No piping shall be covered or put into operation before such testing has been approved.  
C Copper tubing which is out of round will not be acceptable.  
D The arrangement of the piping shall follow the general locations shown on the Drawings, such that clearances, line drainages, etc., shall be maintained.  
E No notching or mitering of copper tubing will be permitted.  
F Joints in Type "K" copper tubing will not be permitted underfloor unless otherwise noted on drawings.  
G In pipe chases, the Contractor shall provide for suspension of all piping from the structure. Do not allow piping to rub against masonry when expanding and contracting.  
H Close and protect open ends of piping until final connections are made. Such closing shall be made with fittings which cannot be easily removed. Caps or plugs shall be required at all times during construction so that no pipes are left open at the end of any day's work, even though continuation is expected the next day.  
I Copper pipe ends shall be reamed, sanded and deburred before soldering. Non-corrosive flux shall be used.  
J Any leaky joints shall be remade with new materials. Caulking to make joints tight is absolutely prohibited.  
K Sleeves shall be provided wherever pipes pass through walls, floors and ceilings. Sleeves shall be Schedule 40, Black Steel, ½ inch in diameter larger than the pipe or insulation on the pipe. Sleeves through walls and ceiling shall be flush. Sleeves through floors shall extend 1 inch above finished floor. Sleeves installed in exterior walls shall be caulked and made water-tight.  
L Pipe joint compound shall be LACO, Hercules, Oatey, or Rector Seal.  
M All water piping shall be hydrostatically tested at 150 psig for a period of one hour.  
N All piping and equipment installed under this Contract shall be tested in the presence of the Engineer and the proper Plumbing Inspector, and provided tight for the periods stated above, or longer if required by the Inspector. The test shall be administered in sections if deemed advisable.  
O No plumbing system or part thereof shall be covered or concealed until after it has been tested and approved. If such work has been covered or concealed before testing, it shall be exposed for testing.

- P Provide non-conducting dielectric connections wherever jointing dissimilar metals.
- Q Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.
- R Install piping to maintain headroom, conserve space, and not interfere with use of space.
- S Group piping whenever practical at common elevations.
- T Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.  
Refer to Section 22 05 16.
- U Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.
  - 1. Refer to Section 22 07 19.
- V Provide access where valves and fittings are not exposed.
  - 1. Coordinate types, sizes, finish, and locations of Access doors with General Contractor, Other Trades, Owner, and Architect prior to completion of wall and/or ceiling framing in all cases.
- W Establish elevations of buried piping outside the building to ensure not less than 2 ft of cover. Provide Additional cover where required by code.
- X PVC Pipe: Make solvent-welded joints in accordance with ASTM D2855.
- Y Manufactured Sleeve-Seal Systems:
  - 1. Install manufactured sleeve-seal systems in sleeves located in grade slabs and exterior concrete walls at piping entrances into building.
  - 2. Provide sealing elements of the size, quantity, and type required for the piping and sleeve inner diameter or penetration diameter.
  - 3. Locate piping in center of sleeve or penetration.
  - 4. Install field assembled sleeve-seal system components in annular space between sleeve and piping.
  - 5. Tighten bolting for a watertight seal.
  - 6. Install in accordance with manufacturer's recommendations.

### 3.04 APPLICATION

- A Where allowed by Piping Material and Type specified, use grooved mechanical couplings and fasteners only in accessible locations.
- B Install unions downstream of valves and at equipment or apparatus connections.
- C Install ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- D Install ball or butterfly valves for throttling, bypass, or manual flow control services.
- E Provide spring-loaded check valves on discharge of water pumps.
- F Provide flow controls in water recirculating systems where indicated.

### 3.05 TOLERANCES

- A Drainage Piping: Establish invert elevations within 1/2 inch vertically of location indicated and slope to drain at minimum of 1/8" per foot or 1/4 inch per foot slope where indicated in plans and required by code.
- B Water Piping: Slope at minimum of 1/32 inch per foot and arrange to drain at low points.

### 3.06 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

- A Prior to starting work, verify system is complete, flushed, and clean.
- B Inject disinfectant, free chlorine in liquid, powder, tablet, or gas form throughout system to obtain 50 to 80 mg/L residual.
- C Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 15 percent of outlets.
- D Maintain disinfectant in system for 24 hours, after which the system shall be flushed prior to being put into service.
- E During the flushing of the system, all flush valves shall be thoroughly flushed out to insure the removal of sediment, pipe dope, etc., from water lines and flush valves, removing such working parts of the flush valves as may be deemed necessary.
- F After flushing of the system has been completed, the Contractor shall have water samples taken and delivered to an independent laboratory for testing to show that the water is suitable for drinking. Copies of the laboratory report shall be provided to the Owner and the Engineer. If the State Construction Office is involved, provide form "Water Test Report for Use."
- G If final disinfectant residual tests less than 25 mg/L, repeat treatment.

### 3.07 DWV SMOKE TEST

- A The final test of the completed drainage and vent systems shall be visual and in sufficient detail to determine compliance with the provisions of the NC Plumbing Code. Where a smoke test is utilized, it shall be made by filling all traps with water and then introducing into the entire system a pungent, thick smoke produced by one or more smoke machines or devices with the appropriate capacity for a system of this size.
- B in sufficient detail to determine compliance with the provisions of the NC Plumbing Code. Where a smoke test is utilized, it shall be made by filling all traps with water and then introducing into the entire system a pungent, thick smoke produced by one or more smoke machines or devices with the appropriate capacity for a system of this size. When the
- C smoke appears at stack openings on the roof (VTRs), the stack openings shall be closed and a pressure equivalent to a 1-inch water column (248.8 Pa) shall be held on the entire system for a test period of not less than 15 minutes while personnel spread throughout the area of the test observe for visual or olfactory detection of smoke. Where leaks or deficiencies are detected they shall be repaired and the test repeated until owner's and engineer of record's representatives are satisfied that the test has been "passed". Written observations (minutes) of the test shall be documented by the Plumbing Contractor and provided for record with O&M Materials.
- D When the smoke appears at stack openings on the roof (VTRs), the stack openings shall be closed and a pressure equivalent to a 1-inch water column (248.8 Pa) shall be held on the entire system for a test period of not less than 15 minutes while personnel spread throughout the area of the test observe for visual or olfactory detection of smoke. Where leaks or deficiencies are detected they shall be repaired and the test repeated until owner's and engineer of record's representatives are satisfied that the test has been "passed".
- E Written observations (minutes) of the test shall be documented by the Plumbing Contractor and provided for record with O&M Materials.

### 3.08 DWV HYDROSTATIC TESTING

- A Waste and vent piping shall be hydrostatically tested at each floor. A test tee will be installed below each floor and pipe will be filled with water for a height of 10' above finished floor. The pipe shall be gas and watertight. Water shall stand in the system for a period of 30 minutes without evidence of leakage. After the waste and vent piping has been hydrostatically tested for the entire system the piping shall be smoke tested using smoke bombs. The contractor shall plug waste line where it exits building, fill all of the traps with water and test the waste and vent piping by using a smoke bomb in a wall or floor cleanout. He shall install a plug on the cleanout once the smoke bomb has been dropped into the cleanout. The smoke bomb test shall be held for thirty minutes without evidence of leakage in the piping. The smoke bombs for this testing shall be furnished by the contractor. Once the testing of the piping has been completed, the contractor shall flush all of the smoke bombs from the waste piping system
- B All piping and equipment installed under this Contract shall be tested in the presence of the Engineer and the proper Plumbing Inspector, and proved tight for the periods stated above, or longer if required by the Inspector
- C The final test of the completed drainage and vent systems shall be visual and
- D No plumbing system or part thereof shall be covered or concealed until after it has been tested and approved.
- E If such work has been covered or concealed before testing, it shall be exposed for testing
- F After the pipe is installed, tested and inspected, backfill shall be installed and compacted. Backfill material shall conform to ASTM D-2371 Soil Class III. Backfill shall be installed, compacted and tested in 6" layers up to 12" above top of pipe. Backfill shall continue in 12" layers to finished grade

### 3.09 DWV UNDERGROUND CAMERA INVESTIGATION

- A The entire underground waste piping system shall be videoed and recorded by the Contractor on an audible CD/DVD to ensure that the Owner knows the location of the piping being viewed. The recorded CD/DVD shall be provided to the Engineer of Record and the Owner's Project Manager three (3) weeks prior to Substantial Completion inspection. The Substantial Completion inspection cannot occur until the video has been reviewed and all the underground waste piping system has been approved by the Engineer in Record.

### 3.10 SCHEDULES

- A Pipe Hanger Spacing:
  - 1. Metal Piping:

- a. Pipe Size: 1/2 inches to 1-1/4 inches:
    - 1) Maximum Hanger Spacing: 6.5 ft.
    - 2) Hanger Rod Diameter: 3/8 inches.
  - b. Pipe Size: 1-1/2 inches to 2 inches:
    - 1) Maximum Hanger Spacing: 10 ft.
    - 2) Hanger Rod Diameter: 3/8 inch.
  - c. Pipe Size: 2-1/2 inches to 3 inches:
    - 1) Maximum Hanger Spacing: 10 ft.
    - 2) Hanger Rod Diameter: 1/2 inch.
  - d. Pipe Size: 4 inches to 6 inches:
    - 1) Maximum Hanger Spacing: 10 ft.
    - 2) Hanger Rod Diameter: 5/8 inch.
  - e. Pipe Size: 8 inches to 12 inches:
    - 1) Maximum hanger spacing: 14 ft.
    - 2) Hanger Rod Diameter: 7/8 inch.
2. Plastic Piping:
    - a. All Sizes:
      - 1) Maximum Hanger Spacing: 6 ft.
      - 2) Hanger Rod Diameter: 3/8 inch.
  3. Install hangers for PEX tubing in strict accordance with manufactures instructions.

**END OF SECTION 22 10 05**

**SECTION 22 10 06**  
**PLUMBING PIPING SPECIALTIES**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A Drains
- B Cleanouts
- C Hose bibbs
- D Hydrants
- E Washing machine boxes and valves
- F Refrigerator valve and recessed box
- G Back water valves
- H Backflow preventers
- I Double check valve assemblies
- J Water hammer arrestors
- K Mixing valves

**1.02 REFERENCE STANDARDS**

- A ADA Standards - Americans with Disabilities Act (ADA) Standards for Accessible Design; 2010.
- B ASME A112.6.3 - Floor Drains; 2022.
- C ASME A112.6.4 - Roof, Deck, and Balcony Drains; 2022.
- D ASSE 1011 - Performance Requirements for Hose Connection Vacuum Breakers; 2023.
- E NSF 61 - Drinking Water System Components - Health Effects; 2022, with Errata.
- F NSF 372 - Drinking Water System Components - Lead Content; 2022.
- G PDI-WH 201 - Water Hammer Arresters; 2017.

**1.03 SUBMITTALS**

- A Product Data: Provide component sizes, rough-in requirements, service sizes, and finishes.
- B Certificates: Certify that grease interceptors meet or exceed specified requirements.
- C Operation Data: Indicate frequency of treatment required for interceptors.
- D Project Record Documents: Record actual locations of equipment, cleanouts, backflow preventers, water hammer arrestors, access panels.
- E Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
  - 1. Extra Loose Keys for Outside Hose Bibbs: One.
  - 2. Extra Hose End Vacuum Breakers for Hose Bibbs: One.

**1.04 QUALITY ASSURANCE**

- A Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than five years documented experience.

**1.05 DELIVERY, STORAGE, AND HANDLING**

- A Accept specialties on site in original factory packaging. Inspect for damage.

**PART 2 PRODUCTS**

**2.01 GENERAL REQUIREMENTS**

- A Specialties in Potable Water Supply Systems: Provide products that comply with NSF 61 and NSF 372 for maximum lead content.

**2.02 DRAINS**

- A Manufacturers:
  - 1. Jay R. Smith Manufacturing Company; \_\_\_\_\_: [www.jayrsmith.com/#sle](http://www.jayrsmith.com/#sle).
  - 2. Josam Company; \_\_\_\_\_: [www.josam.com/#sle](http://www.josam.com/#sle).
  - 3. Zurn Industries, LLC; \_\_\_\_\_: [www.zurn.com/#sle](http://www.zurn.com/#sle).
- B Roof Drains:
  - 1. Assembly: ASME A112.6.4.
  - 2. Body: Lacquered cast iron with sump.
  - 3. Strainer: Removable polyethylene dome with vandal proof screws.
  - 4. Manufacturers:
    - a. Jay R. Smith Manufacturing Company; \_\_\_\_\_: [www.jrsmith.com/#sle](http://www.jrsmith.com/#sle).

- b. Menzies Metal Products; Clamp-Tite Spun Aluminum Drain (Small Bowl): [www.menzies-metal.com/#sle](http://www.menzies-metal.com/#sle).
- c. MIFAB, Inc; \_\_\_\_\_: [www.mifab.com/#sle](http://www.mifab.com/#sle).
- C Floor Drains:
  - 1. Manufacturers:
    - a. ACO, Inc; \_\_\_\_\_: [www.acobuildingdrainage.us/#sle](http://www.acobuildingdrainage.us/#sle).
    - b. Jay R. Smith Manufacturing Company; \_\_\_\_\_: [www.jrsmith.com/#sle](http://www.jrsmith.com/#sle).
    - c. MIFAB, Inc; \_\_\_\_\_: [www.mifab.com/#sle](http://www.mifab.com/#sle).
- D Floor Drain (FD-1):
  - 1. ASME A112.6.3; lacquered cast iron or stainless steel, two piece body with double drainage flange, weep holes, reversible clamping collar, and round, adjustable nickel-bronze strainer.
- E Floor Drain (FD-2):
  - 1. ASME A112.6.3; lacquered cast iron or stainless steel, two piece body with double drainage flange, weep holes, reversible clamping collar, and round, adjustable round nickel bronze strainer with removable perforated sediment bucket.
- F Floor Drain (FD-3):
  - 1. ASME A112.6.3; lacquered cast iron or stainless steel, two piece body with double drainage flange, weep holes, reversible clamping collar, and round, adjustable nickel-bronze strainer with polished bronze funnel or anti-splash rim.
- G Floor Drain (FD-4):
  - 1. ASME A112.6.3; lacquered cast iron or stainless steel, two piece body with double drainage flange, weep holes, reversible clamping collar, and round, adjustable nickel-bronze extra heavy duty strainer.

### 2.03 CLEANOUTS

- A Manufacturers:
  - 1. Jay R. Smith Manufacturing Company; \_\_\_\_\_: [www.jayrsmith.com/#sle](http://www.jayrsmith.com/#sle).
  - 2. Josam Company; \_\_\_\_\_: [www.josam.com/#sle](http://www.josam.com/#sle).
  - 3. MIFAB, Inc; \_\_\_\_\_: [www.mifab.com/#sle](http://www.mifab.com/#sle).
  - 4. Zurn Industries, LLC; \_\_\_\_\_: [www.zurn.com/#sle](http://www.zurn.com/#sle).
- B Cleanouts at Exterior Surfaced Areas (CO-1):
  - 1. Round cast nickel bronze access frame and non-skid cover.
- C Cleanouts at Exterior Unsurfaced Areas (CO-2):
  - 1. Line type with lacquered cast iron body and round epoxy coated gasketed cover.
- D Cleanouts at Interior Finished Floor Areas (CO-3):
  - 1. Lacquered cast iron body with anchor flange, reversible clamping collar, threaded top assembly, and round gasketed scored cover in service areas and round gasketed depressed cover to accept floor finish in finished floor areas.

### 2.04 HOSE BIBBS

- A Manufacturers:
  - 1. Jay R. Smith Manufacturing Company; \_\_\_\_\_: [www.jayrsmith.com/#sle](http://www.jayrsmith.com/#sle).
  - 2. Watts Regulator Company; \_\_\_\_\_: [www.wattsregulator.com/#sle](http://www.wattsregulator.com/#sle).
  - 3. Zurn Industries, LLC; \_\_\_\_\_: [www.zurn.com/#sle](http://www.zurn.com/#sle).
- B Interior Hose Bibbs:
  - 1. Bronze or brass with integral mounting flange, replaceable hexagonal disc, hose thread spout, chrome plated where exposed with handwheel, integral vacuum breaker in compliance with ASSE 1011.
- C Interior Mixing Type Hose Bibbs:
  - 1. Bronze or brass, wall mounted, double service faucet with hose thread spout, integral stops, chrome plated where exposed with handwheels, and vacuum breaker in compliance with ASSE 1011.

### 2.05 WASHING MACHINE BOXES AND VALVES

- A Box Manufacturers:
  - 1. Oatey Supply Chain Services, Inc; \_\_\_\_\_: [www.oatey.com/#sle](http://www.oatey.com/#sle).
- B Valve Manufacturers:



**2.06 REFRIGERATOR VALVE AND RECESSED BOX**

A Box Manufacturers:

1. Oatey Supply Chain Services, Inc; \_\_\_\_\_: [www.oatey.com/#sle](http://www.oatey.com/#sle).

**2.07 BACK WATER VALVES**

A Manufacturers:

1. Jay R. Smith Manufacturing Company; \_\_\_\_\_: [www.jayrsmith.com/#sle](http://www.jayrsmith.com/#sle).
2. Savko Plastic Pipe & Fittings, Inc; \_\_\_\_\_: [www.savko.com/#sle](http://www.savko.com/#sle).
3. Zurn Industries, LLC; \_\_\_\_\_: [www.zurn.com/#sle](http://www.zurn.com/#sle).

**2.08 BACKFLOW PREVENTERS**

A Manufacturers:

1. Apollo Valves; \_\_\_\_\_: [www.apollovalves.com/#sle](http://www.apollovalves.com/#sle).
2. MIFAB, Inc; \_\_\_\_\_: [www.mifab.com/#sle](http://www.mifab.com/#sle).
3. Watts Regulator Company, a part of Watts Water Technologies; \_\_\_\_\_: [www.wattsregulator.com/#sle](http://www.wattsregulator.com/#sle).
4. Zurn Industries, LLC; \_\_\_\_\_: [www.zurn.com/#sle](http://www.zurn.com/#sle).

**2.09 DOUBLE CHECK VALVE ASSEMBLIES**

A Manufacturers:

1. Apollo Valves; \_\_\_\_\_: [www.apollovalves.com/#sle](http://www.apollovalves.com/#sle).
2. Watts Regulator Company, a part of Watts Water Technologies; \_\_\_\_\_: [www.wattsregulator.com/#sle](http://www.wattsregulator.com/#sle).
3. Zurn Industries, LLC; \_\_\_\_\_: [www.zurn.com/#sle](http://www.zurn.com/#sle).

**2.10 WATER HAMMER ARRESTORS**

A Manufacturers:

1. Cash Acme, a brand of Reliance Worldwide Corporation
2. Jay R. Smith Manufacturing Company: [www.jayrsmith.com/#sle](http://www.jayrsmith.com/#sle).
3. Watts Regulator Company, a part of Watts Water Technologies
4. Zurn Industries, LLC

B Water Hammer Arrestors:

1. Stainless steel construction, bellows type sized in accordance with PDI-WH 201, precharged suitable for operation in temperature range minus 100 to 300 degrees F and maximum 250 psi working pressure.

**2.11 RELIEF VALVES**

A Manufacturers:

1. Cash Acme, a brand of Reliance Worldwide Corporation; \_\_\_\_\_: [www.cashacme.com/#sle](http://www.cashacme.com/#sle).
2. ITT Bell & Gossett; \_\_\_\_\_: [www.bellgossett.com/#sle](http://www.bellgossett.com/#sle).

B 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 in accordance with manufacturer's instructions.
- B Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Ensure clearance at cleanout for rodding of drainage system.
- C Encase exterior cleanouts in concrete flush with grade.
- D Install floor cleanouts at elevation to accommodate finished floor.
- E Install approved potable water protection devices on plumbing lines where contamination of domestic water may occur; on boiler feed water lines, janitor rooms, fire sprinkler systems, premise isolation, irrigation systems, flush valves, interior and exterior hose bibbs.
- F Pipe relief from backflow preventer to nearest drain.
- G Install water hammer arrestors complete with accessible isolation valve on hot and cold water supply piping to lavatory sinks, washing machine outlets, or \_\_\_\_\_.

- H Install air chambers on hot and cold water supply piping to each fixture or group of fixtures (each washroom). Fabricate same size as supply pipe or 3/4 inch minimum, and minimum 18 inches long.

**END OF SECTION 22 10 06**

**SECTION 22 11 23**  
**DOMESTIC WATER PUMPS**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

A Circulators.

**1.02 RELATED REQUIREMENTS**

A Section 22 05 13 - Common Motor Requirements for Plumbing Equipment.

B Section 25 15 00 - Integrated Automation Software.

C Section 26 05 83 - Wiring Connections.

**PART 2 PRODUCTS**

**2.01 CIRCULATORS**

A Manufacturers:

1. Armstrong Fluid Technology; \_\_\_\_\_: [www.armstrongfluidtechnology.com/#sle](http://www.armstrongfluidtechnology.com/#sle).

2. Bell & Gossett, a Brand of Xylem, Inc; \_\_\_\_\_: [www.xylem.com/#sle](http://www.xylem.com/#sle).

3. Taco, Inc; \_\_\_\_\_: [www.tacomfort.com/#sle](http://www.tacomfort.com/#sle).

B Casing: Bronze with bronze cast impeller, and stainless steel rotor assembly.

C Shaft: Alloy steel with integral thrust collar and two oil-lubricated bronze sleeve bearings.

D Mechanical Seal: Carbon rotating against a stationary ceramic seat.

E Pipe-End Connection: Union connection.

F Maximum Discharge Pressure: 145 psi.

G Motor: 1,750 rpm, ECM duty with flexible coupling.

H Service Temperature Range: Minus 30 to 250 degrees F.

I Controls: Provide aquastat set for high-temp cutoff, electric plug, and illuminated hand switch.

**END OF SECTION 22 11 23**

**SECTION 22 30 00**  
**PLUMBING EQUIPMENT**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A Water Heaters:
  - 1. Commercial gas fired.
  - 2. Commercial electric.
- B Packaged water heating systems.
- C Domestic water heat exchangers.
- D Domestic hot water storage tanks.
- E Diaphragm-type compression tanks.
- F Reverse osmosis equipment.
- G Deionization equipment.
- H In-line circulator pumps.
- I Pressure booster systems.
- J Sewage ejectors.

**1.02 REFERENCE STANDARDS**

- A ANSI Z21.10.1 - Gas Water Heaters, Volume I, Storage Water Heaters with Input Ratings of 75,000 Btu Per Hour or Less; 2019, with Errata (2020).
- B ANSI Z21.10.3 - Gas-Fired Water Heaters, Volume III, Storage Water Heaters with Input Ratings Above 75,000 Btu Per Hour, Circulating and Instantaneous; 2019.
- C ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1: Rules for Construction of Pressure Vessels; 2023.
- D NEMA MG 1 - Motors and Generators; 2018.
- E NFPA 31 - Standard for the Installation of Oil-Burning Equipment; 2020.
- F NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- G UL 174 - Standard for Household Electric Storage Tank Water Heaters; Current Edition, Including All Revisions.
- H UL 778 - Standard for Motor-Operated Water Pumps; Current Edition, Including All Revisions.
- I UL 1453 - Standard for Electric Booster and Commercial Storage Tank Water Heaters; Current Edition, Including All Revisions.

**1.03 ADMINISTRATIVE REQUIREMENTS**

- A Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.
- B Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

**1.04 SUBMITTALS**

- A See Section 01 30 00 - Administrative Requirements, for submittals procedures.
- B Product Data:
  - 1. Provide dimension drawings of water heaters indicating components and connections to other equipment and piping.
  - 2. Indicate pump type, capacity, power requirements.
  - 3. Provide certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable.
  - 4. Provide electrical characteristics and connection requirements.
- C Project Record Documents: Record actual locations of components.
- D Operation and Maintenance Data: Include operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.
- E Warranty Documentation: Submit manufacturer warranty and ensure that 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. Extra Pump Seals: One of each type and size.

### 1.05 QUALITY ASSURANCE

- A Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum ten years of documented experience.
- B Certifications:
  - 1. Water Heaters: NSF approved.
  - 2. Gas Water Heaters: Certified by CSA International to ANSI Z21.10.1, as applicable, in addition to requirements specified elsewhere.
  - 3. Electric Water Heaters: UL listed and labeled to UL 174.
  - 4. Oil-Fired Water Heaters: To NFPA 31.
  - 5. Pressure Vessels for Heat Exchangers: ASME labeled to ASME BPVC-VIII-1.
  - 6. Water Tanks: ASME labeled to ASME BPVC-VIII-1.
  - 7. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.
- C Identification: Provide pumps with manufacturer's name, model number, and rating/capacity identified by permanently attached label.
- D Performance: Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, operate within 25 percent of midpoint of published maximum efficiency curve.
- E ASME STAMP: All Boilers, Water Heaters, and/or Pressure Vessels and their components shall bear the ASME Stamp and where applicable shall bear the ASME HLW stamp.

### 1.06 DELIVERY, STORAGE, AND HANDLING

- A Provide temporary inlet and outlet caps. Maintain caps in place until installation.

### 1.07 WARRANTY

- A See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B Provide seven year manufacturer warranty for domestic water heaters.

## PART 2 PRODUCTS

### 2.01 WATER HEATERS

- A Manufacturers:
  - 1. A.O. Smith Water Products Co
  - 2. Bock Water Heaters, Inc
  - 3. Rheem Manufacturing Company
  - 4. State Water Heater
  - 5. Tankless - Stiebel Eltron, Chronomite, Navien, Lochinvar
  - 6. Bradford-White
  - 7. LAARS
  - 8. Substitutions: Not permitted.
- B Commercial Gas Fired:
  - 1. Type: Automatic, natural gas-fired, vertical storage.
  - 2. Performance:
    - a. Energy Factor: see fixture schedule.
    - b. Storage Capacity: see fixture schedule gal.
    - c. First Hour Rating: see fixture schedule gal.
    - d. Input: see fixture schedule Btuh at sea level.
    - e. Minimum Recovery Rate: see fixture schedule gph with 100 degrees F temperature rise.
    - f. Maximum Working Pressure: 150 psig.
  - 3. Tank: Glass-Lined, Duplex Alloy, Nickel-Plated, or approved lining, welded steel ASME labeled; multiple flue passages, 4 inch diameter inspection port, thermally insulated with minimum 2 inches glass fiber, encased in corrosion-resistant steel jacket; baked-on enamel finish; floor shield and legs.
  - 4. Accessories:
    - a. Water Connections: Brass.
    - b. Dip Tube: Brass.
    - c. Drain valve.

- d. Anode: By Manufacturer.
- e. Temperature and Pressure Relief Valve: ASME labeled.
- 5. Certified For The Following Applications:
  - a. Automatic storage water heater.
  - b. Automatic circulating tank water heater.
  - c. For operation at 180 degrees F.
  - d. For operation on combustible floors.
- 6. Controls: Automatic direct immersion thermostat with temperature range adjustable minimum 175 degrees F differential, automatic reset high temperature limiting thermostat factory set at 195 degrees F, gas pressure regulator, multi-ribbon or tubular burner, 100 percent safety shut-off pilot and thermocouple, intermittent electronic ignition monitoring pilot and main flame, trial for re-ignition for momentary loss of flame, shutdown of pilot and main burner in "2 to 4" seconds after loss of flame, and automatic flue damper.
- C Commercial Electric:
  - 1. Type: Factory-assembled and wired, electric, vertical storage.
  - 2. Performance:
    - a. Energy Factor: see fixture schedule.
    - b. Storage Capacity: see fixture schedule gal.
    - c. First Hour Rating: see fixture schedule gal.
    - d. Heating Element Size: see fixture schedule kW.
    - e. Number of Heating Elements: see fixture schedule.
    - f. Minimum Recovery Rate: see fixture schedule gph with 100 degrees F temperature rise.
    - g. Maximum Working Pressure: 150 psig.
  - 3. Electrical Characteristics:
    - a. see fixture schedule volts, single phase, 60 Hz.
    - b. see fixture schedule amperes maximum fuse size.
  - 4. Tank: glass lined, duplex alloy, nickel plating, or approved lining welded steel; 4 inch diameter inspection port, thermally insulated with minimum 2 inches glass fiber encased in corrosion-resistant steel jacket; baked-on enamel finish.
  - 5. Controls: Automatic immersion water thermostat; externally adjustable temperature range from 60 to 180 degrees F, flanged or screw-in nichrome elements, high temperature limit thermostat.
  - 6. Accessories:
    - a. Water Connections: Brass.
    - b. Dip Tube: By Manufacturer.
    - c. Drain valve.
    - d. Anode: By Manufacturer.
    - e. Temperature and Pressure Relief Valve: ASME labeled.
  - 7. Controls: Ventilated control cabinet, factory-wired with solid state progressive sequencing step controller, fuses, magnetic contactors, control transformer, pilot lights indicating main power and heating steps, control circuit toggle switch, electronic low-water (probe-type) cut-off, high temperature limit thermostat, flush-mounted temperature and pressure gauges.
  - 8. Heating Elements: Flange-mounted immersion elements; individual elements sheathed with Incoloy corrosion-resistant metal alloy, rated less than 75 W/sq in.

## 2.02 DOMESTIC HOT WATER STORAGE TANKS

- A Manufacturers:
  - 1. Tanks shall be by same manufacturer of water heaters where possible - submitted tanks from different manufacturers will be reviewed on a case by case basis assuming water heater manufacturer selected does not also make tanks.
- B Tank: Welded steel, ASME labeled for working pressure of 125 psig, steel support saddles, tappings for accessories, threaded connections of stainless steel, access manhole.
- C Openings: Up to 3 inches, copper-silicone threaded; over 4 inches, flanged; flanged collar for heat exchanger; manway fitting.

- D Accessories: Tank drain, water inlet and outlet, thermometer range of 40 to 200 degrees F, ASME pressure relief valve suitable for maximum working pressure.

### 2.03 DIAPHRAGM-TYPE COMPRESSION TANKS

- A Manufacturers:
  - 1. Amtrol Inc: [www.amtrol.com/#sle](http://www.amtrol.com/#sle).
  - 2. Bell & Gossett, a xylem brand: [www.bellgossett.com/#sle](http://www.bellgossett.com/#sle).
  - 3. Taco, Inc: [www.taco-hvac.com/#sle](http://www.taco-hvac.com/#sle).
  - 4. Watts.
  - 5. Substitutions: Not permitted.
- B Construction: Welded steel, tested and stamped in accordance with ASME BPVC-VIII-1; supplied with National Board Form U-1, rated for working pressure of 125 psig, with flexible EPDM diaphragm sealed into tank, and steel legs or saddles.
- C Accessories: Pressure gauge and air-charging fitting, tank drain; precharge to 12 psig.

### 2.04 IN-LINE CIRCULATOR PUMPS

- A Manufacturers:
  - 1. Armstrong Fluid Technology: [www.armstrongfluidtechnology.com/#sle](http://www.armstrongfluidtechnology.com/#sle).
  - 2. Bell & Gossett, a xylem brand: [www.bellgossett.com/#sle](http://www.bellgossett.com/#sle).
  - 3. Taco.
  - 4. Grundfos
  - 5. Substitutions: Not permitted.
- B Casing: Bronze, rated for 125 psig working pressure, with stainless steel rotor assembly.
- C Impeller: Bronze.
- D Shaft: Alloy steel with integral thrust collar and two oil lubricated bronze sleeve bearings.
- E Seal: Carbon rotating against a stationary ceramic seat.
- F Drive: Flexible coupling.
- G Performance:

### 2.05 ELECTRICAL WORK

- A Provide electrical motor driven equipment specified complete with motors, motor starters, controls, and wiring.
- B Electrical characteristics to be as specified or indicated.
- C Furnish motor starters complete with thermal overload protection and other appurtenances necessary for the motor control specified.
- D Supply manual or automatic control and protective or signal devices required for the operation specified, and any control wiring required for controls and devices not shown.

## PART 3 EXECUTION

### 3.01 INSTALLATION

- A Install plumbing equipment in accordance with manufacturer's instructions, as required by code, and complying with conditions of certification, if any.
- B Coordinate with plumbing piping and related fuel piping work to achieve operating system.
- C Domestic Water Storage Tanks:
  - 1. Provide steel pipe or concrete pad support, independent of building structural framing members.
  - 2. Clean and flush prior to delivery to site. Seal until pipe connections are made.
- D Pumps:
  - 1. Ensure shaft length allows sump pumps to be located minimum 24 inches below lowest invert into sump pit and minimum 6 inches clearance from bottom of sump pit.
  - 2. Provide air cock and drain connection on horizontal pump casings.
  - 3. Provide line sized isolating valve and strainer on suction and line sized soft seated check valve and balancing valve on discharge.
  - 4. 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. Provide supports under elbows on pump suction and discharge line sizes 4 inches and over.

5. Ensure pumps 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.
6. Align and verify alignment of base mounted pumps prior to start-up

**END OF SECTION 22 30 00**



**SECTION 22 40 00**  
**PLUMBING FIXTURES**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A Water closets
- B Urinals
- C Lavatories
- D Sinks
- E Service sinks
- F Mop sinks.
- G Under-lavatory pipe supply covers.
- H Electric water coolers
- I Showers
- J Eye and face wash fountains
- K Emergency showers

**1.02 REFERENCE STANDARDS**

- A ADA Standards - Americans with Disabilities Act (ADA) Standards for Accessible Design; 2010.
- B ANSI Z358.1 - American National Standard for Emergency Eyewash and Shower Equipment; 2014.
- C ASME A112.6.1M - Floor-Affixed Supports for Off-the-Floor Plumbing Fixtures for Public Use; 1997 (Reaffirmed 2017).
- D ASME A112.18.1 - Plumbing Supply Fittings; 2018, with Errata.
- E ASME A112.18.9 - Protectors/Insulators for Exposed Waste and Supplies on Accessible Fixtures; 2011 (Reaffirmed 2022).
- F ASME A112.19.1 - Enamelled Cast Iron and Enamelled Steel Plumbing Fixtures; 2018.
- G ASME A112.19.2 - Ceramic Plumbing Fixtures; 2018, with Errata.
- H ASME A112.19.3 - Stainless Steel Plumbing Fixtures; 2022.
- I ASME A112.19.4M - Porcelain Enamelled Formed Steel Plumbing Fixtures; 1994 (Reaffirmed 2009).
- J ASME A112.19.5 - Flush Valves and Spuds for Water Closets, Urinals, and Tanks; 2022.
- K ASME A112.19.14 - Six-Liter Water Closets Equipped with a Dual Flushing Device; 2013 (Reaffirmed 2018).
- L ASSE 1070 - Performance Requirements for Water Temperature Limiting Devices; 2020.
- M ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2018b.
- N IAPMO Z124 - Plastic Plumbing Fixtures; 2022.
- O ICC A117.1 - Accessible and Usable Buildings and Facilities; 2017.
- P ISFA 2-01 - Classification and Standards for Solid Surfacing Material; 2013.
- Q NSF 61 - Drinking Water System Components - Health Effects; 2022, with Errata.
- R NSF 372 - Drinking Water System Components - Lead Content; 2022.

**1.03 SUBMITTALS**

- A Product Data: Provide catalog illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.

**1.04 DELIVERY, STORAGE, AND HANDLING**

- A Accept fixtures on site in factory packaging only. Inspect for damage.
- B Protect products from damage while transporting, handling, or in storage.
- C Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.

**PART 2 PRODUCTS**

**2.01 GENERAL REQUIREMENTS**

- A Potable Water Systems: Provide plumbing fittings and faucets that comply with NSF 61 and NSF 372 for maximum lead content; label pipe and fittings.

**2.02 FLUSH VALVE WATER CLOSETS**

- A Water Closets: Vitreous china, ASME A112.19.2, siphon jet flush action, china bolt caps.
  - 1. Manufacturers:

- a. American Standard, Inc
  - b. Zurn Industries, Inc
  - c. Toto
  - d. Sloan
- B Flush Valves: ASME A112.18.1, diaphragm type, complete with vacuum breaker stops and accessories.
1. Sensor-Operated Type: Solenoid operator, normal voltage or battery as indicated in fixture schedule, infrared sensor with mechanical over-ride or over-ride push button.
  2. Concealed Type: Rough brass, exposed parts chrome plated, wall escutcheon, wheel handle stop.
  3. Exposed Type: Chrome plated, escutcheon, integral screwdriver stop.
  4. Metering Type: Easily accessible adjustment nut.
  5. Manufacturers:
    - a. Hydrotek:
    - b. Delany Products:
    - c. Sloan Valve Company:
    - d. Zurn Industries, Inc:
- C Seats:
1. Manufacturers:
    - a. American Standard, Inc
    - b. Bemis Manufacturing Company
    - c. Church Seat Company
    - d. Olsonite: [www.olsonite.com/#sle](http://www.olsonite.com/#sle).
    - e. Zurn Industries, Inc
  2. Solid white plastic, open front, extended back, self-sustaining hinge, brass bolts, without cover unless otherwise specified in fixture schedule.
- D Water Closet Carriers:
1. Manufacturers:
    - a. JOSAM Company; \_\_\_\_\_: [www.josam.com/#sle](http://www.josam.com/#sle).
    - b. Zurn Industries, Inc; \_\_\_\_\_: [www.zurn.com/#sle](http://www.zurn.com/#sle).
    - c. JR Smith \_\_\_\_\_.
    - d. Watts
  2. ASME A112.6.1M; adjustable cast iron frame, integral drain hub and vent, adjustable spud, lugs for floor and wall attachment, threaded fixture studs with nuts and washers.

### 2.03 WALL HUNG URINALS

- A Wall Hung Urinal Manufacturers:
1. American Standard, Inc
  2. Zurn
  3. Sloan
  4. Toto
- B Urinals: Vitreous china, ASME A112.19.2, wall hung with side shields and concealed carrier.
1. Flush Volume: 0.125 gallons, maximum.
  2. Flush Valve: Exposed (top spud).
  3. Flush Operation: Sensor operated.
  4. Trap: Integral.
  5. Supply Size: 3/4 inch.
  6. Outlet Size: 2 inches.
- C Flush Valves: ASME A112.18.1, diaphragm type, complete with vacuum breaker stops and accessories.
1. Sensor-Operated Type: Solenoid or motor-driven operator, low voltage hard-wired, infrared sensor with mechanical over-ride or over-ride push button.
  2. Exposed Type: Chrome plated, escutcheon, integral screwdriver stop.
- D Carriers:
1. Manufacturers:
    - a. Jay R. Smith MFG. Co; \_\_\_\_\_: [www.jrsmith.com/#sle](http://www.jrsmith.com/#sle).

- b. JOSAM Company; \_\_\_\_\_: [www.josam.com/#sle](http://www.josam.com/#sle).
  - c. Zurn Industries, Inc; \_\_\_\_\_: [www.zurn.com/#sle](http://www.zurn.com/#sle).
2. ASME A112.6.1M; cast iron and steel frame with tubular legs, lugs for floor and wall attachment, threaded fixture studs for fixture hanger, bearing studs.

#### 2.04 LAVATORIES

- A Lavatory Manufacturers:
1. American Standard, Inc; \_\_\_\_\_: [www.americanstandard-us.com/#sle](http://www.americanstandard-us.com/#sle).
  2. Kohler Company; \_\_\_\_\_: [www.kohler.com/#sle](http://www.kohler.com/#sle).
  3. Zurn Industries, Inc; \_\_\_\_\_: [www.zurn.com/#sle](http://www.zurn.com/#sle).
- B Vitreous China Wall Hung Basin: ASME A112.19.2; vitreous china wall hung lavatory, \_\_\_ by \_\_\_ inch minimum, with 4 inch high back, rectangular basin with splash lip, front overflow, and soap depression.
1. Drilling Centers: 4 inch.
- C Supply Faucet Manufacturers:
1. Kohler Company: [www.kohler.com/#sle](http://www.kohler.com/#sle).
  2. Zurn Industries, Inc: [www.zurn.com/#sle](http://www.zurn.com/#sle).
- D Supply Faucet: ASME A112.18.1; chrome plated combination supply fitting with pop-up waste, water economy aerator with maximum flow of 2.2 gallons per minute, indexed handles.

#### 2.05 WALL-HUNG MULTI-STATION LAVATORY UNITS - SOLID SURFACE

- A Description: Rectilinear, level-surface deck, seamless and integral elongated basin, with stainless steel enclosed pedestal cabinet.
- B Deck and Bowl Material: Fabricate from molded engineered stone material consisting of natural quartz, granite, and other minerals in a matrix of thermoset acrylic modified bio-based polyester resin and meeting requirements of IAPMO Z124.
- C Surface Burning Characteristics: Smoke developed index less than 450, and flame spread index less than 25, Class A, when tested in accordance with ASTM E84.
- D Unit Length: \_\_\_\_\_ inches.
- E Soap Dispenser:
- F Color: As selected by Architect from manufacturer's full line.
- G Faucet Drilling: 4 inch (100 mm) centerset drilling.
- H Sensor-Operated Faucets:
1. High profile metering faucet with infrared and external temperature control.
  2. Vandal-resistant meeting requirements of ASME A112.18.1 and ADA Standards compliant.
  3. Body: Polished chrome plated commercial solid cast brass, with 4 inch (102 mm) centerset mounting with anti-rotation trim plate.
  4. Tempered Water Supply: ADA Standards compliant lever on faucet body.
  5. Aerator: Flow rate of 0.5 gal/min at an operating range of 20 to 80 psi.
  6. Sensor Module: Water conserving, vandal-resistant adjustable sensor unit with timing turn-off delay and stationary object automatic timed cutoff, with battery diagnostic light, serviceable from above deck.
  7. Power Supply: Battery-operated single faucet with 6V lithium battery and single 115 VAC plug-in adapter.
  8. Thermostatic Mixing Valve: Thermostatic mixing valve, ASSE 1070 listed, with combination stop, strainer, and check valves, and flexible stainless steel connectors.
- I Access Panel: Stainless steel.

#### 2.06 SINKS

- A Sink Manufacturers:
1. American Standard, Inc; \_\_\_\_\_: [www.americanstandard-us.com/#sle](http://www.americanstandard-us.com/#sle).
  2. Kohler Company; \_\_\_\_\_: [www.kohler.com/#sle](http://www.kohler.com/#sle).
  3. (See fixture schedule).
- B Single Compartment Bowl: ASME A112.19.3; \_\_\_\_\_ by \_\_\_\_\_ by \_\_\_\_\_ inch outside dimensions 20 gage, 0.0359 inch thick, Type 302 stainless steel, self rimming and undercoated, with ledge back drilled for trim.
1. Drain: 1-1/2 inch chromed brass drain.

## 2.07 UNDER-LAVATORY PIPE SUPPLY COVERS

### A Manufacturers:

1. Plumberex Specialty Products, Inc; \_\_\_\_\_: [www.plumberex.com/#sle](http://www.plumberex.com/#sle).

### B General:

1. Insulate exposed drainage piping including hot, cold and tempered water supplies under lavatories or sinks per ADA Standards.
2. Construction: 1/8 inch PVC with antimicrobial, antifungal and UV resistant properties.
  - a. Comply with ASME A112.18.9 for covers on accessible lavatory piping.
  - b. Comply with ICC A117.1.

## 2.08 SHOWERS

### A Shower Manufacturers:

1. American Standard, Inc; \_\_\_\_\_: [www.americanstandard-us.com/#sle](http://www.americanstandard-us.com/#sle).
2. Aqua Glass Corporation; \_\_\_\_\_: [www.aquaglass.com/#sle](http://www.aquaglass.com/#sle).
3. Kohler Company; \_\_\_\_\_: [www.kohler.com/#sle](http://www.kohler.com/#sle).
4. Symmons (see fixture schedule)

## 2.09 ELECTRIC WATER COOLERS

### A Electric Water Cooler Manufacturers:

1. Elkay Manufacturing Company; \_\_\_\_\_: [www.elkay.com/#sle](http://www.elkay.com/#sle).
2. Haws Corporation; \_\_\_\_\_: [www.hawsc.com/#sle](http://www.hawsc.com/#sle).

### B Water Cooler: Electric, mechanically refrigerated; surface mounted, ADA compliant; stainless steel top, vinyl on steel body, elevated anti-squirt bubbler with stream guard, automatic stream regulator, push button, mounting bracket; integral air cooled condenser and stainless steel grille.

1. Capacity: 8 gallons per hour of 50 degrees F water with inlet at 80 degrees F and room temperature of 90 degrees F, when tested in accordance with ASHRAE Std 18.
2. Electrical: 115 V, 60 Hertz compressor, 6 foot cord and plug for connection to electric wiring system including grounding connector.

### C Bottle Filler: Materials to match fountain.

## 2.10 BI-LEVEL, ELECTRIC WATER COOLERS

### A Bi-level, Electric Water Cooler Manufacturers:

1. Elkay Manufacturing Company; \_\_\_\_\_: [www.elkay.com/#sle](http://www.elkay.com/#sle).
2. Haws Corporation; \_\_\_\_\_: [www.hawsc.com/#sle](http://www.hawsc.com/#sle).

### B Water Cooler: Bi-level, electric, mechanically refrigerated; surface mounted, ADA compliant; stainless steel top, vinyl on steel body, elevated anti-squirt bubbler with stream guard, automatic stream regulator, push button, mounting bracket; integral air cooled condenser and stainless steel grille.

1. Capacity: 8 gallons per hour of 50 degrees F water with inlet at 80 degrees F and room temperature of 90 degrees F, when tested in accordance with ASHRAE Std 18.
2. Electrical: 115 V, 60 Hertz compressor, 6 foot cord and plug for connection to electric wiring system including grounding connector.

### C Bottle Filler: Materials to match fountain.

## 2.11 MOP SINKS

### A Mop Sink Manufacturers:

1. Just Manufacturing Company; \_\_\_\_\_: [www.justmfg.com/#sle](http://www.justmfg.com/#sle).
2. Zurn Industries, Inc; \_\_\_\_\_: [www.zurn.com/#sle](http://www.zurn.com/#sle).

### B Tiling Flange Construction: Galvanized steel.

### C Dimensions: As indicated on drawings.

### D Terrazzo Mop Sink Manufacturers:

## 2.12 SERVICE SINKS

### A Service Sink Manufacturers:

1. American Standard, Inc; \_\_\_\_\_: [www.americanstandard-us.com/#sle](http://www.americanstandard-us.com/#sle).
2. Elkay Manufacturing Company; \_\_\_\_\_: [www.elkay.com/#sle](http://www.elkay.com/#sle).
3. Just Manufacturing Company; \_\_\_\_\_: [www.justmfg.com/#sle](http://www.justmfg.com/#sle).
4. Zurn Industries, Inc; \_\_\_\_\_: [www.zurn.com/#sle](http://www.zurn.com/#sle).

5. FIAT (see fixture schedule).

### 2.13 EMERGENCY EYE AND FACE WASH

- A Emergency Wash Manufacturers:
  1. Bradley.
  2. Guardian
  3. Haws
  4. Speakman
  5. Approved Equal
- B Emergency Wash: ANSI Z358.1; wall-mounted, self-cleaning, non-clogging eye and face wash with quick opening, full-flow valves, stainless steel eye and face wash receptor, twin eye wash heads and face spray ring, stainless steel dust cover, copper alloy control valve and fittings.

### 2.14 EMERGENCY SHOWERS

- A Emergency Shower Manufacturers:
  1. Bradley.
  2. Guardian
  3. Haws
  4. Speakman
  5. Approved Equal
- B Emergency Shower: ANSI Z358.1; wall-mounted, self-cleaning, non-clogging 8 inch diameter stainless steel deluge shower head with elbow, one inch full flow valve with pull chain and 8 inch diameter ring, one inch interconnecting fittings.

## PART 3 EXECUTION

### 3.01 EXAMINATION

- A Verify that walls and floor finishes are prepared and ready for installation of fixtures.
- B Verify that electric power is available and of the correct characteristics.
- C Confirm that millwork is constructed with adequate provision for the installation of counter top lavatories and sinks.

### 3.02 PREPARATION

- A Rough-in fixture piping connections in accordance with minimum sizes indicated in fixture rough-in / connection schedule found in the drawings for particular fixtures unless piping sizes are otherwise noted on plans and/or risers in drawings.

### 3.03 INSTALLATION

- A Install each fixture with trap, easily removable for servicing and cleaning.
- B Provide chrome plated rigid supplies to fixtures with loose key stops, reducers, and escutcheons. Stainless Steel Flexible supplies may be used only when previously approved by the engineer or where specified in drawings.
- C Install fixtures and components level and plumb.
- D Install and secure fixtures in place according to manufacturer's recommendations with fixture manufacturer's supplied wall supports and bolts where required and unless otherwise stated in drawings.
- E Solidly attach water closets to floor with lag screws. Lead flashing is not intended hold fixture in place.
- F All plumbing fixtures, with the exception of Electric Water Coolers, shall be neatly caulked to the wall or floor with paintable white silicone caulking compound. Countertop lavatories shall be caulked watertight.

### 3.04 INTERFACE WITH WORK OF OTHER SECTIONS

- A Review millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation. Notify Engineer of conflicts or discrepancies prior to the start of work.

### 3.05 ADJUSTING

- A Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.

### 3.06 CLEANING

- A Thoroughly Clean all plumbing fixtures and equipment.

### 3.07 PROTECTION

- A Protect installed products from damage due to subsequent construction operations.
- B Do not permit use of fixtures by construction personnel.

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C Repair or replace damaged products before Date of Substantial Completion.

**END OF SECTION 22 40 00**

**SECTION 23 01 00**  
**HVAC GENERAL PROVISIONS**

**PART 1 GENERAL**

**1.01 SCOPE OF WORK**

- A The Contractor shall provide all materials, equipment and labor necessary to install and set into operation the heating and air conditioning equipment as shown on the Engineering Drawings and as contained herein.
- B Intent of the drawings and specifications is to obtain complete systems, tested, adjusted, and ready for operation.
- C Include incidental details not usually indicated or specified, but necessary for proper installation and operation.

**1.02 QUALITY ASSURANCE**

- A Refer to the General and Supplementary General Conditions and Division 01.
- B Check, verify, and coordinate work with drawings and specifications of other trades. Include modifications, relocations, and adjustments necessary to complete work or to avoid interference with other trades.
- C All work shall be in accordance with local, state and federal regulations. Minimum requirements shall be the North Carolina State Building Code.
- D The Contractor shall be responsible for obtaining all permits and shall notify inspection departments as work progresses.
- E Whenever the words "Approval", "Approved", or "Approved Equal" appear, it is intended that items other than the model number specified shall be subject to the approval of the engineer.
- F Where a submitted product has electrical requirements that differ from the Basis of Design specified product, it is the Mechanical Contractor's responsibility to coordinate the electrical requirements of the equipment with the Electrical Engineer and Electrical Contractor at no additional cost to the project.
- G All material and equipment that the Contractor proposed to substitute in lieu of those specified in the Specifications, shall be submitted to the Engineer ten (10) days prior to the bid date for evaluation. The submittal shall include a full description of the material or equipment and all pertinent engineering data required to substantiate the equality of the proposed item to that specified. Items that are submitted for approval after this date will not be accepted.
- H "Provide" as used herein shall mean that the Contractor responsible shall furnish and install said item or equipment. "Furnish" as used herein shall mean that the Contractor responsible shall acquire and make available said item or equipment and that installation shall be by others. "Install" as used herein shall mean that the Contractor responsible shall make installation of items or equipment furnished by others.

**1.03 REQUIREMENT OF REGULATORY AGENCIES**

- A Rules and regulations of Federal, State, and local authorities having jurisdiction, and utility companies, in force at time of execution of contract shall become part of this specification.

**1.04 SUBSTITUTIONS**

- A Products are specified for use on this project by one of the following:
  - 1. Reference Standards and Description: Any products meeting the Reference Standards and Description will be acceptable (i.e., piping).
  - 2. Naming of a product as an example to denote the quality standard of the product desired, in which case three or more brands will be denoted (where applicable) to establish equivalent designs. Naming of a product does not restrict Bidders to a specific brand (i.e., fixtures, valves, etc.).
  - 3. Requests for approval of manufacturer's or substitutions which have not been preapproved shall be made by using the forms at the end of this section.
- B During bidding period: Submitted written requests from Bidders Only, using the forms herein, will be considered if received ten (10) calendar days prior to the date of receipt of bids to allow for proper evaluation. Requests from suppliers or subcontractors will not be considered. Substitutions will be considered when a product becomes unavailable through no fault of the Contractor. A request constitutes a representation that the Bidder/Contractor:
  - 1. Has investigated proposed product and determined that it meets or exceeds the quality level of the specified product and is suitable for use in the Work.
  - 2. Will provide the same warranty for the substitution as for the specified product.

3. Will coordinate installation and make changes to other work which may be required for the work to be complete with no additional cost to the Owner.
  4. Waives claims for additional cost or time extension which may subsequently become apparent.
  5. Has included a list of similar projects on which this product has been used with names and telephone numbers for verification.
  6. Has written verification from the product manufacturer that this product has been in use a minimum of two (2) years on a project similar to this work.
  7. Substitutions will not be considered when they are indicated or implied on shop drawing or product data submittals, without separate written request, or when acceptance will require revision to the Contract Documents.
- C Architect/Engineer Review
1. Review and approval will rely on manufacturer's literature and other data as outlined herein.
  2. Inadequacies in such submittals that fail to identify unsuitability are the responsibility of the parties making submittal.
- D Substitution Procedure
1. Submit three copies of request for substitution for consideration. Limit each request to one proposed substitution.
  2. Submit shop drawings, product data, and certified test results attesting to the proposed product equivalence.
  3. Submit listing of similar projects.
  4. Submit manufacturer's written verification that product has been in use a minimum of two (2) years at similar projects.
  5. The Architect/Engineer will notify Contractor, in writing, of decision to accept or reject request.
  6. Products bid or incorporated in the work that are not specified and without written approval of the Architect/Engineer may not be acceptable, and if not, the Contractor will be required to furnish and install the products specified.
  7. The Architect/Engineer will issue written approvals of product substitutions to all Bidders. Substitutions are not approved without written approval.
  8. FORMS: Copy forms incorporated at the end of this section and use for all product substitution requests.

#### 1.05 SUBMITTALS

- A Refer to General and Supplementary General Conditions and Division 01.
- B For satisfying submittal requirements for Division 23, "Product Data" is usually more appropriate than true "Shop Drawings" as defined in Division 01. However, the term "Shop Drawings" may be used throughout the specifications.
- C Within ten days after notification of the award of the Contract and written notice to begin work, the Contractor shall submit to the Architect/Engineer for approval a detailed list of equipment and material which he proposes to use. Items requiring submittal data for approval will be noted at this time.
- D Mark general catalog sheets and drawings to indicate specific items submitted and their correlation to specific tagged equipment on the drawings. Cross out all nonapplicable or extraneous information that does not apply to the submitted equipment. Circle or otherwise clearly indicate applicable options.
- E Contractor shall clearly indicate deviations (if any) from the project specifications on each submittal. Shop drawings accepted by the Engineer shall not relieve the Contractor of their responsibility to construct the work in accordance with the Contract Documents.
- F Include proper identification of equipment or item by name and/or number, as indicated on the Drawings.
- G Where manufacturer's reference numbers differ from those specified, clearly indicate such on the submittal.
- H Where equipment or items specified include accessories, parts, and additional items under one designation, submittals shall be complete and include all required components.
- I Equipment requiring electrical connections shall include composite wiring diagrams, motor efficiency, and power factor data. Wiring diagrams submitted shall be specific to project conditions.
- J Where submittals cover products containing non-metallic materials, include MSDS sheets from the manufacturer stating physical and chemical properties of components and precautionary steps to be taken.



- K The Contractor shall provide an electronic PDF copy of submittal data. The pdf shall contain complete submittal data on all products, methods, etc. proposed for use on the project.
- L Each submittal shall bear the approval of the Contractor indicating that he has reviewed the data and found it to meet the requirements of the specifications as well as space limitations and other project conditions. The submittals shall be clearly identified showing project name, manufacturer's catalog number, and all necessary performance and fabrication data.
- M The Contractor shall submit to the Engineer a set of accurately marked up plans indicating all changes encountered during the construction. Final payment will be contingent on receipt of these as-built plans.
- N The Contractor shall furnish an electronic PDF copy of maintenance and operating instructions as outlined in Paragraph C (Execution), of this specification section.
- O The Contractor shall submit to the Owner all certificates required for operating system in compliance with local, state and federal regulations.

**1.06 PRODUCT DELIVERY, STORAGE AND HANDLING**

- A All material and equipment shall be delivered and unloaded by the Contractor within the project site as noted herein or as directed by the Owner.
- B The Contractor shall protect all material and equipment from breakage, theft, or weather damage. No material or equipment shall be stored on the ground.
- C The material and equipment shall remain the property of the Contractor until the project has been completed and turned over to the Owner.

**1.07 WORK CONDITIONS AND COORDINATION**

- A The Contractor shall review the electrical plans to establish points of connection and the extent of electrical work to be provided in his Contract. All electrical work shall be performed by a licensed electrical contracting firm.
- B This Contractor shall be responsible for the final electrical connections to all equipment installed as part of his contract.
- C Electrical work shall be in accordance with all local, state and national codes and as specified in Division 26.
- D Where architectural features and elements govern location of work, refer to Architectural drawings prior to fabrication of materials or system components.
- E Refer to the Structural Drawings to become familiar with structural member sizes, framing type and configuration, opening sizes, and other details that could impact the work. Failure to coordinate with the Work of other trades, resulting in relocation of installed work to coordinate with architectural and/or structural elements, shall NOT be allowed as a basis for extra compensation by the contractor.
- F Where piping, ductwork, or other items are indicated to be routed in the webbing of joists or trusses, the mechanical contractor shall confirm with the General Contractor/Construction Manager and steel supplier the final joist/truss profile prior to fabricating or order materials. The actual final joist/truss profile shall be used in the BIM coordination effort.
- G Openings for insulated piping shall be based on the outside diameter of the insulation with continuous insulation through the opening.
- H Seal non-fire rated floor penetrations with non-shrink grout or urethane caulk, as appropriate.
- I Seal non-rated wall openings with urethane caulk.
- J Duct/pipe/conduit penetrations through floor slabs of mechanical platforms or slabs above the bottom floor shall have water stopped curb surrounding the pipe/duct/conduit opening. Coordinate with Construction Manager/General Contractor to confirm openings based on Coordination Drawings.
- K Pipe, conduit and duct chases required for installation of work shall be provided by the General Contractor unless otherwise noted. This Contractor shall be responsible for coordinating the location of all required chases.
- L All work shall be coordinated with other trades. Cutting of new work and subsequent patching shall be at the Contractor's expense at no extra cost to the Owner.
- M Contractor shall review the complete construction document package and determine, prior to the bid, which portions of the above grade structural slabs are hard rock concrete and/or light weight insulating concrete. Contractor shall review the Structural Engineer's requirements for attachment of loads to slabs, joists, trusses, and other structural members. DO NOT exceed point loads on Structural Engineer's drawings and

details. Unistrut and/or other support apparatus required to span multiple joists or beams shall be included in the Contractor's bid. No additional monies will be given for support steel or other components required to support Mechanical piping, duct, equipment, or other items.

**1.08 GUARANTEE**

- A See the General and Supplementary General Conditions
- B Where extended warranties or guarantees are available from the manufacturer, the Contractor shall prepare the necessary contract documents to validate these warranties as required by the manufacturer and present them to the Architect/Engineer.
- C The Contractor shall include in his bid a full warranty and guarantee for a five (5) year period on the compressors for the refrigeration equipment, including all chillers. This warranty does not include labor following the first year's Labor and Material Warranty.

**PART 2 PRODUCT**

**2.01 GENERAL REQUIREMENTS**

- A Materials and equipment shall be new, unless noted otherwise, of the highest grade and quality and free from defects or other imperfections. Materials and equipment found defective shall be removed and replaced at the contractor's expense.
- B The contractor shall provide name plates for identification of all equipment, switches, panels, etc.
- C The name plates shall be laminated phenolic plastic, black front and back with white core, white engraved letters (1/4" minimum) etched into the white core. Name plates shall be fastened with sheet metal screws.

**PART 3 EXECUTION**

**3.01 INSPECTION**

- A This Contractor shall examine the areas of completed work and shall insure that no defects or errors are present which would result in the poor application or installation of subsequent work.

**3.02 TEMPORARY SERVICES**

- A Refer to Division 01

**3.03 INSTALLATION**

- A All work shall be performed in a manner indicating proficiency in the trade.
- B Contractor may install additional piping, fittings, valves, etc., not indicated on the drawings, for testing purposes or for convenience to facilitate installation of the work. Where such materials are installed, they shall comply with the specifications and shall be sizes to be compatible with system design. Remove such materials when they interfere with design conditions or as directed by the Engineer.
- C Use of access panels in inaccessible ceilings for access to equipment, valves, dampers, etc., is not permitted, unless access panels are indicated on the Architectural reflected ceiling plans. Review any locations where additional access panels may be required with the Architect prior to incorporating into Work.
- D This Contractor shall be responsible for completely cleaning the fireproofing from ALL materials or equipment installed as part of this Contract. This includes, but is not limited to, ductwork, piping, conduit, equipment, faceplates, boxes, disconnects, control panels, and cabling.
- E All conduit, pipes, ducts, etc. shall be either parallel to building walls or plumb where installed in a vertical position and shall be concealed when located in architecturally finished areas.
- F Any cutting or patching required for installation of this Contractor's work shall be kept to a minimum. Written approval shall be required by the Architect/Engineer if cutting of primary structure is involved.
- G All patching shall be done in such a manner as to restore the areas or surfaces to match existing finishes.
- H The Contractor shall lay out and install his work in advance of pouring concrete floors or walls. He shall furnish all sleeves to the General Contractor for openings through poured masonry floors or walls, above grade, required for passage of all conduits, pipes, or ducts installed by him. The Contractor shall provide all inserts and hangers required to support his equipment.
- I The annular space around ALL wall and floor penetrations shall be properly sealed. For rated assemblies, a UL listed method shall be used. For non-rated wall and floors, the annular space shall be packed with mineral wool, or another suitable non-combustible material, and caulked air tight.
- J Installation of piping and ductwork shall not interfere with walkways or service access.
- K All trapeze hanger rods shall be cut to within 1" of the bottom nut.

- L Provide minimum 1/2" thick closed cell elastomeric foam insulation, applied with adhesive, on lower edges of equipment and mechanical duct and pipe supporting elements suspended less than 7 ft above finished floors, platforms, or roofs.

**3.04 PERFORMANCE**

- A The Contractor shall perform all excavation and backfill operations necessary for installation of his work.

**3.05 ERECTION**

- A All support steel, angles, channels, pipes or structural steel stands and anchoring devices that may be required to rigidly support or anchor material and equipment shall be provided by this Contractor.

**3.06 FIELD QUALITY CONTROL**

- A The Contractor shall conform to the requirements of Division 3 for concrete testing.
- B All testing required for compliance with the Contract shall be as stated in subsequent sections.

**3.07 ADJUST AND CLEAN**

- A All equipment and installed materials shall be thoroughly clean and free of all dirt, oil, grit, grease, etc.
- B Clean piping and ductwork both internally and externally to remove dirt, dust, debris, and other foreign matter. When external surfaces of piping are rusted, clean and restore surface to original condition.
- C Clean all equipment as recommended by the manufacturer.
- D Factory painted equipment shall not be repainted unless damaged areas exist. These areas shall be touched up with a material suitable for intended service. In no event shall name plates be painted.
- E Dirt, dust, and other foreign matter shall be blown and/or cleaned from coils, terminal devices, diffusers, registers, and grilles. Inspect all coils and comb coil fins where damaged to as-new condition prior to test and balance work.
- F If the Owner has doubts or concerns about the cleanliness of the ductwork or air handling systems, the Owner reserves the right to have a third-party assessment performed by a board certified indoor environmental consultant to determine if the installation meets requirements as stipulated in the National Air Duct Cleaners Association (NADCA) Assessment, Cleaning, and Restoration of HVAC Systems. If duct systems or air handling units are found to have accumulated dirt or foreign matter on interior surfaces in violation of NADCA guidelines, the Contractor shall be responsible for all costs required to restore the air distribution system to new condition to the satisfaction of the Owner. This shall include payment for all costs associated with third party testing of the systems.
- G At a scheduled meeting, the Contractor shall instruct the Owner or the Owner's representative in the operation and maintenance of all equipment installed under his Contract (in the presence of the Engineer).
- H Equipment with filter media shall be run for a period of two (2) weeks after completion of work at which time a new filter media shall be installed with one change of filter media provided the Owner for future replacement. (Provide a total of three (3) sets).
- I The Contractor shall adjust the tension on all belts six months after the final inspection.

**3.08 TESTING AND BALANCING**

- A Tests for equipment, ductwork, piping, and other systems shall be performed as specified in their respective sections in accordance with technical requirements indicated.
- B Provide equipment and devices required for testing, including fittings for additional openings as required for the test apparatus.
- C All ductwork and piping inspections and testing shall be successfully completed with test reports reviewed and approved by the Engineer before concealment or application of covering materials.
- D Testing shall be witnessed by the Engineer, unless otherwise indicated. Notify Engineer, Owner, Commission Authority, and other parties at least 72 hours in advance of testing date. Engineer, at his discretion, may opt not to witness a given test. In this case, The Construction Manager/General Contractor and/or CxA shall witness the test and forward results to Engineer for review.
- E Contractor shall be responsible for certifying in writing all equipment and system test results. Certification shall include identification of portion of system tested, date, time, weather conditions, test criteria, testing medium, and pressure used, duration of test, and name and title of person signing test certification document. Results shall be submitted to Engineer within three (3) days of test completion.

**3.09 MAINTENANCE AND OPERATING MANUAL**

- A The Contractor shall prepare a PDF version of the manual describing the proper maintenance and system operation. This manual shall not consist of standard factory printed data intended for dimension or design purposes (although these may be included), but shall be prepared to describe this particular job. This manual shall include the following:
  - 1. A check list for periodic maintenance of all equipment.
  - 2. Suggested setting of all controls and switches for normal operation, with description of control and its location.
  - 3. A check list for seasonal shutdown.
  - 4. Maintenance and spare parts data for each major piece of equipment.
  - 5. As-built wiring, interlock and control diagrams for equipment with color coding shown on wiring and interlock diagrams.
  - 6. Air and Water Balance Report.
- B The PDF shall be indexed, bookmarked, dated and signed by the Contractor when completed.
- C The operating and maintenance manuals shall be submitted to the Engineer for approval. When the manuals are considered complete by the Engineer, they will be turned over to the Owner for their permanent use.
- D For each major piece of equipment, the Contractor shall organize and record on video the on-site training sessions. A copy of the video shall be turned over to the Owner at the completion of the project.

**END OF SECTION 23 01 00**

**SECTION 23 05 13**

**COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A General construction and requirements.
- B Applications.
- C Single phase electric motors.
- D Three phase electric motors.
- E Electronically Commutated Motors (ECM).

**1.02 RELATED REQUIREMENTS**

- A Section 26 05 83 - Wiring Connections: Electrical characteristics and wiring connections.

**1.03 REFERENCE STANDARDS**

- A ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings; 2015.
- B IEEE 112 - IEEE Standard Test Procedure for Polyphase Induction Motors and Generators; 2017.
- C NEMA MG 1 - Motors and Generators; 2018.
- D NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

**1.04 SUBMITTALS**

- A See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B Product Data: Provide wiring diagrams with electrical characteristics and connection requirements.
- C Test Reports: Indicate test results verifying nominal efficiency and power factor for three phase motors larger than 1/2 horsepower.
- D Manufacturer's Installation Instructions: Indicate setting, mechanical connections, lubrication, and wiring instructions.
- E Operation Data: Include instructions for safe operating procedures.
- F Maintenance Data: Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

**1.05 QUALITY ASSURANCE**

- A Manufacturer Qualifications: Company specializing in manufacture of electric motors for general use, and their accessories, with minimum three years documented product development, testing, and manufacturing experience.
- B Comply with NFPA 70.
- C Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

**1.06 DELIVERY, STORAGE, AND HANDLING**

- A Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

**1.07 WARRANTY**

- A See Section 01 78 00 - Closeout Submittals for additional warranty requirements.

**PART 2 PRODUCTS**

**2.01 GENERAL CONSTRUCTION AND REQUIREMENTS**

- A Electrical Service: Refer to Section 26 05 83 for required electrical characteristics.
- B Construction:
  - 1. Open drip-proof type except where specifically noted otherwise.
  - 2. Design for continuous operation in 104 degrees F environment.
  - 3. Design for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
- C Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.
- D Wiring Terminations:
  - 1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.

2. For fractional horsepower motors where connection is made directly, provide threaded conduit connection in end frame.

## 2.02 APPLICATIONS

- A Exception: Motors less than 250 watts, for intermittent service may be the equipment manufacturer's standard and need not comply with these specifications.
- B Single phase motors for shaft mounted fans or blowers: Permanent split capacitor type.
- C Motors located in exterior locations and air cooled condensers: Totally enclosed type.

## 2.03 SINGLE PHASE POWER - SPLIT PHASE MOTORS

- A Starting Torque: Less than 150 percent of full load torque.
- B Starting Current: Up to seven times full load current.
- C Breakdown Torque: Approximately 200 percent of full load torque.
- D Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve or ball bearings.
- E Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

## 2.04 SINGLE PHASE POWER - PERMANENT-SPLIT CAPACITOR MOTORS

- A Starting Torque: Exceeding one fourth of full load torque.
- B Starting Current: Up to six times full load current.
- C Multiple Speed: Through tapped windings.
- D Open Drip-proof or Enclosed Air Over Enclosure: Class A (50 degrees C temperature rise) insulation, minimum 1.0 Service Factor, prelubricated sleeve or ball bearings, automatic reset overload protector.

## 2.05 THREE PHASE POWER - SQUIRREL CAGE MOTORS

- A Starting Torque: Between 1 and 1-1/2 times full load torque.
- B Starting Current: Six times full load current.
- C Power Output, Locked Rotor Torque, Breakdown or Pull Out Torque: NEMA Design B characteristics.
- D Design, Construction, Testing, and Performance: Comply with NEMA MG 1 for Design B motors.

## 2.06 ELECTRONICALLY COMMUTATED MOTORS (ECM)

- A Applications:
  1. Commercial:
    - a. Roof Top Unit:
      - 1) Operating Mode: Constant speed.
      - 2) Input: Motor manufacturer to coordinate control requirements with the control board of the roof top unit and/or specified sequence of operation.
    - b. Hydronic Blower Coil Unit:
      - 1) Operating Mode: Constant cfm.
      - 2) Input: Motor manufacturer to coordinate control requirements with the control board of the fan coil unit and/or specified sequence of operation.
    - c. Package Terminal Air Conditioner (PTAC):
      - 1) Operating Mode: Constant speed.
      - 2) Input: Motor manufacturer to coordinate control requirements with the control board of the PTAC and/or specified sequence of operation.
    - d. Power Roof Ventilator (PRV):
      - 1) Operating Mode: Constant cfm.
      - 2) Input: Motor manufacturer to coordinate control requirements with the control board of the PRV and/or specified sequence of operation.

## PART 3 EXECUTION

### 3.01 INSTALLATION

- A Install in accordance with manufacturer's instructions.
- B Install securely on firm foundation. Mount ball bearing motors with shaft in any position.
- C Check line voltage and phase and ensure agreement with nameplate.

**END OF SECTION 23 05 13**

**SECTION 23 05 17**  
**SLEEVES AND SLEEVE SEALS FOR HVAC PIPING**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A Pipe sleeves.
- B Pipe-sleeve seals.

**1.02 RELATED REQUIREMENTS**

- A Section 07 84 00 - Firestopping.
- B Section 23 05 23 - General-Duty Valves for HVAC Piping.
- C Section 23 05 53 - Identification for HVAC Piping and Equipment: Piping identification.
- D Section 23 07 16 - HVAC Equipment Insulation.
- E Section 23 07 19 - HVAC Piping Insulation.

**1.03 REFERENCE STANDARDS**

- A ASTM C592 - Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type); 2022a.
- B ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems; 2013a (Reapproved 2017).
- C FM (AG) - FM Approval Guide; Current Edition.
- D UL (DIR) - Online Certifications Directory; Current Edition.

**1.04 SUBMITTALS**

- A See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B Shop Drawings: Indicate pipe materials used, jointing methods, supports, floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.
- C Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
  - 1. See Section 01 60 00 - Product Requirements, for additional provisions.

**1.05 QUALITY ASSURANCE**

- A Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- B Installer Qualifications: Company specializing in performing work of the type specified this section.
  - 1. Minimum three years experience.
  - 2. Approved by manufacturer.
- C Clean equipment, pipes, valves, and fittings of grease, metal cuttings, and sludge that may have accumulated from the installation and testing of the system.

**1.06 DELIVERY, STORAGE, AND HANDLING**

- A Deliver and store sleeve and sleeve seals in shipping containers, with labeling in place.
- B Provide temporary protective coating on cast iron and steel sleeves if shipped loose.

**1.07 WARRANTY**

- A See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B Correct defective Work within a five year period after Date of Substantial Completion.

**PART 2 PRODUCTS**

**2.01 PIPE SLEEVES**

- A Manufacturers:
  - 1. Flexicraft Industries; Pipe Wall Sleeve: [www.flexicraft.com/#sle](http://www.flexicraft.com/#sle).
- B Vertical Piping:
  - 1. Sleeve Length: 1 inch above finished floor.
  - 2. Provide sealant for watertight joint.
- C Sheet Metal: Pipe passing through interior walls, partitions, and floors, unless steel or brass sleeves are specified below.
- D Clearances:
  - 1. Provide allowance for insulated piping.
  - 2. Wall, Floor, Partitions, and Beam Flanges: 1 inch greater than external pipe diameter.

3. All Rated Openings: Caulked tight with fire stopping material in compliance with ASTM E814 in accordance with Section 07 84 00 to prevent the spread of fire, smoke, and gases.

## **2.02 PIPE-SLEEVE SEALS**

- A Manufacturers:
  1. Advance Products & Systems, LLC; Innerlynx: [www.apsonline.com/#sle](http://www.apsonline.com/#sle).
  2. American Polywater Corporation; PGKD Modular Seals: [www.polywater-haufftechnik.com/#sle](http://www.polywater-haufftechnik.com/#sle).
  3. Flexicraft Industries; PipeSeal: [www.flexicraft.com/#sle](http://www.flexicraft.com/#sle).
- B Modular Mechanical Sleeve-Seal:
  1. Elastomer-based interlocking links continuously fill annular space between pipe and wall-sleeve, wall or casing opening.
  2. Watertight seal between pipe and wall-sleeve, wall or casing opening.
  3. Size and select seal component materials in accordance with service requirements.
  4. Glass-reinforced plastic pressure end plates.
- C Sealing Compounds:
  1. Provide packing and sealing compound to fill pipe to sleeve thickness.
  2. Combined packing and seal compound is to match partition fire-resistance hourly rating.
- D Wall Sleeve: Steel material with waterstop collar, and nailer end-caps.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.
- B Install piping to conserve building space, to not interfere with use of space and other work.
- C Install piping and pipe sleeves to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- D Provide sleeves when penetrating footings, floors, walls, and partitions. Seal pipe including sleeve penetrations to achieve fire resistance equivalent to fire separation required.
  1. Aboveground Piping:
    - a. Pack solid using mineral fiber in compliance with ASTM C592.
    - b. Fill space with an elastomer caulk to a depth of 0.50 inch where penetrations occur between conditioned and unconditioned spaces.
- E Manufactured Sleeve-Seal Systems:
  1. Install manufactured sleeve-seal systems in sleeves located in grade slabs and exterior concrete walls at piping entrances into building.
  2. Provide sealing elements of the size, quantity, and type required for the piping and sleeve inner diameter or penetration diameter.
  3. Locate piping in center of sleeve or penetration.
  4. Install field assembled sleeve-seal system components in annular space between sleeve and piping.
  5. Tighten bolting for a water-tight seal.
  6. Install in accordance with manufacturer's recommendations.
- F When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

**END OF SECTION 23 05 17**



**SECTION 23 05 19**  
**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 RELATED REQUIREMENTS**

- A Section 23 21 13 - Hydronic Piping.

**1.03 REFERENCE STANDARDS**

- A ASME B40.100 - Pressure Gauges and Gauge Attachments; 2022.
- B ASTM E1 - Standard Specification for ASTM Liquid-in-Glass Thermometers; 2014 (Reapproved 2020).
- C ASTM E77 - Standard Test Method for Inspection and Verification of Thermometers; 2014 (Reapproved 2021).
- D UL 393 - Indicating Pressure Gauges for Fire-Protection Service; Current Edition, Including All Revisions.

**1.04 SUBMITTALS**

- A See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B Product Data: Provide list that indicates use, operating range, total range and location for manufactured components.

**PART 2 PRODUCTS**

**2.01 PRESSURE GAUGES**

- A Manufacturers:
  - 1. Dwyer Instruments, Inc; \_\_\_\_\_: [www.dwyer-inst.com/#sle](http://www.dwyer-inst.com/#sle).
  - 2. Moeller Instrument Company, Inc; \_\_\_\_\_: [www.moellerinstrument.com/#sle](http://www.moellerinstrument.com/#sle).
  - 3. Omega Engineering, Inc; \_\_\_\_\_: [www.omega.com/#sle](http://www.omega.com/#sle).
- B Pressure Gauges: ASME B40.100, UL 393 drawn steel case, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background.
  - 1. Case: Steel with brass bourdon tube.
  - 2. Size: 4-1/2 inch diameter.
  - 3. Mid-Scale Accuracy: One percent.

**2.02 PRESSURE GAUGE TAPPINGS**

- A Gauge Cock: Tee or lever handle, brass for maximum 150 psi.
- B Needle Valve: Brass, 1/4 inch NPT for minimum 150 psi.

**2.03 STEM TYPE THERMOMETERS**

- A Manufacturers:
  - 1. Dwyer Instruments, Inc; \_\_\_\_\_: [www.dwyer-inst.com/#sle](http://www.dwyer-inst.com/#sle).
  - 2. Omega Engineering, Inc; \_\_\_\_\_: [www.omega.com/#sle](http://www.omega.com/#sle).
  - 3. Weksler Glass Thermometer Corp; \_\_\_\_\_: [www.wekslerglass.com/#sle](http://www.wekslerglass.com/#sle).
- B Thermometers - Fixed Mounting: Red- or blue-appearing non-toxic liquid in glass; ASTM E1; lens front tube, cast aluminum case with enamel finish.
  - 1. Size: 9 inch scale.
  - 2. Window: Clear Lexan.
  - 3. Stem: \_\_\_\_\_ inch brass.
  - 4. Accuracy: 2 percent, per ASTM E77.
  - 5. Calibration: Degrees F.

**2.04 THERMOMETER SUPPORTS**

- A Socket: Brass separable sockets for thermometer stems with or without extensions as required, and with cap and chain.

**PART 3 EXECUTION**

**3.01 INSTALLATION**

- A Install in accordance with manufacturer's instructions.
- B 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.

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

**END OF SECTION 23 05 19**

**SECTION 23 05 23**  
**GENERAL-DUTY VALVES FOR HVAC PIPING**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A Applications.
- B Ball valves.
- C Butterfly valves.
- D Check valves.
- E Chainwheels.

**1.02 ABBREVIATIONS AND ACRONYMS**

- A CWP: Cold working pressure.
- B EPDM: Ethylene propylene copolymer rubber.
- C NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
- D NRS: Nonrising stem.
- E OS&Y: Outside screw and yoke.
- F PTFE: Polytetrafluoroethylene.
- G RS: Rising stem.
- H SWP: Steam working pressure.
- I TFE: Tetrafluoroethylene.
- J WOG: Water, oil, and gas.

**1.03 REFERENCE STANDARDS**

- A ASME B1.20.1 - Pipe Threads, General Purpose, Inch; 2013 (Reaffirmed 2018).
- B ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250; 2020.
- C ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard; 2020.
- D ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2021.
- E ASME B31.9 - Building Services Piping; 2020.
- F ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators; 2023.
- G ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings; 2004 (Reapproved 2019).
- H ASTM A395/A395M - Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures; 1999 (Reapproved 2022).
- I ASTM A536 - Standard Specification for Ductile Iron Castings; 1984, with Editorial Revision (2019).
- J AWWA C606 - Grooved and Shouldered Joints; 2022.
- K MSS SP-67 - Butterfly Valves; 2022.
- L MSS SP-71 - Gray Iron Swing Check Valves, Flanged and Threaded Ends; 2018.
- M MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; 2010, with Errata .
- N MSS SP-125 - Check Valves: Gray Iron and Ductile Iron, In-Line, Spring-Loaded, Center-Guided; 2018.

**1.04 SUBMITTALS**

- A Product Data: Provide data on valves including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.
- B Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.
- C Maintenance Materials: Furnish Owner with one size of each type of valve on the project.

**1.05 QUALITY ASSURANCE**

- A Manufacturer:
  - 1. Obtain valves for each valve type from single manufacturer.
  - 2. Company must specialize in manufacturing products specified in this section, with not less than three years of documented experience.
- B Welding Materials and Procedures: Comply with ASME BPVC-IX.

## 1.06 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. Secure check valves in either the closed position or open position.
  - 5. 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. Isolation (Shutoff): Butterfly and Ball.
  - 2. Swing Check (Pump Outlet):
    - a. Size 2 inch and Smaller: Bronze with bronze disc.
    - b. 2-1/2 NPS and Larger: Iron with center guided with stainless steel seat.
  - 3. Dead-End: Butterfly, single-flange (lug) type.
- C Substitutions of valves with higher CWP classes or WSP ratings for same valve types are permitted when specified CWP ratings or WSP classes are not available.
- D 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: Welded.
  - 2. Copper Tube:
    - a. 2 NPS and Smaller: Solder-joint valve-ends.
- E Heating Hot Water Valves:
  - 1. 2 NPS and Smaller, Bronze Valves:
    - a. Threaded ends for steel pipe.
    - b. Soldered ends for copper pipe.
    - c. Ball: Full port, two piece, stainless steel trim.
    - d. Swing Check: Bronze disc, Class 125.
  - 2. 2-1/2 NPS and Larger, Iron Valves:
    - a. Single-Flange Butterfly: 2-1/2 NPS to 12 NPS, aluminum-bronze disc, EPDM seat, 200 CWP.
    - b. Center-Guided Check: Compact-wafer, resilient seat, Class 125.

### 2.02 MANUFACTURERS

- A Provide all valves of each type from a single manufacturer.
- B Manufacturers:
  - 1. Anvil
  - 2. Apollo
  - 3. Hammond
  - 4. ITT Grinnell
  - 5. Milwaukee
  - 6. Nibco

7. Victaulic
8. Or Approved Equal

### 2.03 GENERAL REQUIREMENTS

- A Valve Pressure and Temperature Ratings: No less than rating indicated.
- B Valve Sizes: Match upstream piping unless otherwise indicated.
- C Valve Actuator Types:
  1. Gear Actuator: Quarter-turn valves 8 NPS and larger.
  2. Handwheel: Valves other than quarter-turn types.
  3. Hand Lever: Quarter-turn valves 6 NPS and smaller.
  4. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator, of size and with chain for mounting height, as indicated in the "Valve Installation" Article.
- D Valves in Insulated Piping: Provide 2-1/4" stem extensions and the following features:
  1. Hot Water Ball Valves: Metal stem extension is acceptable.
  2. 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. Pipe Flanges and Flanged Fittings 1/2 NPS through 24 NPS: ASME B16.5.
  4. Solder Joint Connections: ASME B16.18.
  5. Grooved End Connections: AWWA C606.
- F General ASME Compliance:
  1. 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.

### 2.04 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 Stainless Steel Trim:
  1. Comply with MSS SP-110.
  2. SWP Rating: 150 psig.
  3. CWP Rating: 600 psig.
  4. Body: Bronze
  5. Stem: 316 Stainless steel.
  6. Ball: Stainless steel vented.
  7. Handle: Provide lever handle with 2-1/4" stem extension for insulation. On chilled water valves or other fluids below ambient temperature, use non-conductive handle extensions.

### 2.05 IRON, SINGLE FLANGE BUTTERFLY VALVES

- A Lug type: Bi-directional dead end service without downstream flange.
  1. Comply with MSS SP-67, Type I.
  2. CWP Rating: 150 psig and 200 psig.
  3. Body Material: ASTM A536 ductile iron.
  4. Seat: EPDM or Viton.
  5. Disc: Aluminum-bronze or stainless steel.

### 2.06 IRON, CENTER-GUIDED CHECK VALVES

- A Class 150, Compact-Wafer:
  1. Comply with MSS SP-125.
  2. 2-1/2 NPS to 12 NPS, CWP Rating: 300 psig.
  3. Body Material: ASTM A395/A395M or ASTM A536, ductile iron or cast iron.
  4. Resilient Seat: EPDM, NBR, or stainless steel.

**2.07 CHAINWHEELS**

- A Description: Valve actuation assembly with sprocket rim, brackets, and chain.
  - 1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
  - 2. Attachment: For connection to butterfly valve stems.
  - 3. Sprocket Rim with Chain Guides: Ductile iron include zinc coating.
  - 4. Chain: Hot-dip galvanized steel. Sized to fit sprocket rim.

**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 be 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 All valves shall be installed within 24" of the lay-in ceiling.
- C DO NOT install valves above cable tray.
- D Provide separate valve support as required and locate valve with stem at or above center of piping, maintaining unimpeded stem movement.
- E Where valve support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc-rich primer to welds.
- F Install check valves where necessary to maintain direction of flow as follows:
  - 1. Swing Check: Install horizontal maintaining hinge pin level.
  - 2. Orient center-guided into horizontal or vertical position, between flanges.
- G Provide chainwheels on operators for valves 8" and larger where located 96" or more above finished floor, terminating 60" above finished floor.

**END OF SECTION 23 05 23**

**SECTION 23 05 29**

**HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A Support and attachment components.

**1.02 RELATED REQUIREMENTS**

- A Section 03 30 00 - Cast-in-Place Concrete: Concrete equipment pads.
- B Section 05 50 00 - Metal Fabrications: Materials and requirements for fabricated metal supports.

**1.03 REFERENCE STANDARDS**

- A ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.
- B ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2016a.
- C ASTM A181/A181M - Standard Specification for Carbon Steel Forgings, for General-Purpose Piping; 2022.
- D ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.
- E ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings; 1999, with Editorial Revision (2022).
- F ASTM A283/A283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates; 2018.
- G ASTM A395/A395M - Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures; 1999 (Reapproved 2022).
- H ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2019.
- I ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2018b.
- J ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2022a, with Editorial Revision (2023).
- K FM (AG) - FM Approval Guide; Current Edition.
- L MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2018, with Amendment (2019).
- M UL (DIR) - Online Certifications Directory; Current Edition.
- N UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

**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. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
    - a. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
    - b. 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. Strut Channel or Bracket Material:
    - a. Indoor Dry Locations: Use zinc-plated steel or galvanized steel.
    - b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel.
  - 2. Minimum Channel Thickness: Steel sheet, 12 gauge, 0.1046 inch.
  - 3. Minimum Channel Dimensions: 1-5/8 inch width by 13/16 inch height.
  - 4. Accessories: Provide bracket covers, cable basket clips, cable tray clips, clamps, conduit clamps, fire-retarding brackets, j-hooks, protectors, and vibration dampeners.

- C Hanger Rods:
  - 1. Threaded zinc-plated steel unless otherwise indicated.
  - 2. Minimum Size, Unless Otherwise Indicated or Required:
    - a. Equipment Supports: 1/2 inch diameter.
    - b. Piping up to 1 inch: 1/4 inch diameter.
    - c. Piping larger than 1 inch: 3/8 inch diameter.
    - d. Trapeze Support for Multiple Pipes: 3/8 inch diameter.
- 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 calcium silicate insulation surrounded by a 360 degree, PVC jacketing.
  - 2. PVC Jacket:
    - a. Pipe insulation protection shields to be provided with a ball bearing hinge and locking seam.
    - b. Minimum Service Temperature: Minus 40 degrees F.
    - c. Maximum Service Temperature: 180 degrees F.
    - d. Moisture Vapor Transmission: 0.0071 perm inch, when tested in accordance with ASTM E96/E96M.
    - e. Thickness: 60 mil.
- E 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 zinc finish.
  - 3. Small or Junior Beam Clamp: MSS SP-58 type 19, malleable iron with zinc 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, plated 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.
- F 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, steel with stainless steel or zinc plated finish.
  - 3. Medium Split Horizontal Pipe Clamp: MSS SP-58 type 4, carbon 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.
- G Pipe Hangers:
  - 1. Split Ring Hangers:
    - a. Provide hinged split ring and yoke roller hanger with zinc finish.
    - b. Material: ASTM A47/A47M malleable iron or ASTM A36/A36M carbon steel.
    - c. Provide hanger rod and nuts of the same type and material for a given pipe run.
    - d. Provide coated or plated hangers to isolate steel hangers from dissimilar metal tube or pipe.
- H Pipe Shields for Insulated Piping:
  - 1. General Construction and Requirements:
    - a. Surface Burning Characteristics: Comply with ASTM E84 or UL 723.
    - b. Shields Material: UV-resistant polypropylene with glass fill.
    - 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.

I Anchors and Fasteners:

- 1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.

**PART 3 EXECUTION**

**3.01 INSTALLATION**

- A Install products in accordance with manufacturer's instructions.
- B Provide independent support from building structure. Do not provide support from piping, ductwork, conduit, or other systems.
- C Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.
- D Unless specifically indicated or approved by Architect, do not provide support from roof deck.
- E Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- F Provide thermal insulated pipe supports complete with hangers and accessories. Install thermal insulated pipe supports during the installation of the piping system.
- 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. Unless otherwise indicated, mount floor-mounted equipment on properly sized 6 high concrete pad constructed in accordance with Section 03 30 00.
  - 5. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
- H Secure fasteners according to manufacturer's recommended torque settings.
- I Remove temporary supports.

**END OF SECTION 23 05 29**

**SECTION 23 05 48**  
**VIBRATION AND SEISMIC CONTROLS FOR HVAC**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A Vibration isolation requirements.
- B Vibration-isolated equipment support bases.
- C Vibration-isolated and/or seismically engineered roof curbs.

**1.02 REFERENCE STANDARDS**

- A ASHRAE (HVACA) - ASHRAE Handbook - HVAC Applications; Most Recent Edition Cited by Referring Code or Reference Standard.

**1.03 SUBMITTALS**

- A See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B Product Data: Provide manufacturer's standard catalog pages and data sheets for products, including materials, fabrication details, dimensions, and finishes.
  - 1. Vibration Isolators: Include rated load capacities and deflections; include information on color coding or other identification methods for spring element load capacities.

**PART 2 PRODUCTS**

**2.01 VIBRATION ISOLATION REQUIREMENTS**

- A Design and provide vibration isolation systems to reduce vibration transmission to supporting structure from vibration-producing HVAC equipment and/or HVAC connections to vibration-isolated equipment.
- B Comply with applicable general recommendations of ASHRAE (HVACA), where not in conflict with other specified requirements:
- C General Requirements:
  - 1. Select vibration isolators to provide required static deflection.
  - 2. Select vibration isolators for uniform deflection based on distributed operating weight of actual installed equipment.
- D Equipment Isolation: RTU's and BCU's.

**2.02 VIBRATION-ISOLATED EQUIPMENT SUPPORT BASES**

- A Manufacturers:
  - 1. Vibration-Isolated Equipment Support Bases:
    - a. Kinetics Noise Control, Inc: [www.kineticsnoise.com/#sle](http://www.kineticsnoise.com/#sle).
    - b. Mason Industries: [www.mason-ind.com/#sle](http://www.mason-ind.com/#sle).
    - c. Vibration Eliminator Company, Inc: [www.veco-nyc.com/#sle](http://www.veco-nyc.com/#sle).
    - d. Vibro-Acoustics: [www.vibro-acoustics.com/#sle](http://www.vibro-acoustics.com/#sle).
  - 2. Source Limitations: Furnish vibration-isolated equipment support bases and associated components and accessories produced by the same manufacturer as the vibration isolators and obtained from a single supplier.

**2.03 VIBRATION-ISOLATED AND/OR SEISMICALLY ENGINEERED ROOF CURBS**

- A Manufacturers:
  - 1. Vibration-Isolated and/or Seismically Engineered Roof Curbs:
    - a. Kinetics Noise Control, Inc: [www.kineticsnoise.com/#sle](http://www.kineticsnoise.com/#sle).
    - b. Mason Industries: [www.mason-ind.com/#sle](http://www.mason-ind.com/#sle).
    - c. Vibration Eliminator Company, Inc: [www.veco-nyc.com/#sle](http://www.veco-nyc.com/#sle).
    - d. Vibro-Acoustics: [www.vibro-acoustics.com/#sle](http://www.vibro-acoustics.com/#sle).
- B Vibration Isolation Curbs:
  - 1. Nonseismic Curb:
    - a. Location: Between structure and rooftop equipment.
    - b. Construction: Aluminum.
    - c. Integral vibration isolation to comply with requirements of this section.
    - d. Weather exposed components consist of corrosion resistant materials.
    - e. Provide calculations and anchoring details for high wind zone listed on drawings.

**PART 3 EXECUTION**

**3.01 EXAMINATION**

- A Verify that field measurements are as shown on the drawings.
- B Verify that mounting surfaces are ready to receive vibration isolation and/or seismic control components and associated attachments.
- 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 anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.
- C Secure fasteners according to manufacturer's recommended torque settings.
- D Install flexible piping connections to provide sufficient slack for vibration isolation and/or seismic relative displacements as indicated or as required.
- E Vibration Isolation Systems:
  - 1. Vibration-Isolated Equipment Support Bases:
    - a. Provide specified minimum clearance beneath base.
  - 2. Spring Isolators:
    - a. Position equipment at operating height; provide temporary blocking as required.
    - b. Lift equipment free of isolators prior to lateral repositioning to avoid damage to isolators.
    - c. Level equipment by adjusting isolators gradually in sequence to raise equipment uniformly such that excessive weight or stress is not placed on any single isolator.
  - 3. Clean debris from beneath vibration-isolated equipment that could cause short-circuiting of isolation.
  - 4. Use elastomeric grommets for attachments where required to prevent short-circuiting of isolation.
  - 5. Adjust isolators to be free of isolation short circuits during normal operation.
  - 6. Do not overtighten fasteners such that resilient material isolator pads are compressed beyond manufacturer's maximum recommended deflection.

**END OF SECTION 23 05 48**

**SECTION 23 05 53**  
**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 RELATED REQUIREMENTS**

- A Section 09 91 23 - Interior Painting: Identification painting.

**1.03 REFERENCE STANDARDS**

- A ASME A13.1 - Scheme for the Identification of Piping Systems; 2020.
- B ASTM D709 - Standard Specification for Laminated Thermosetting Materials; 2017.

**1.04 SUBMITTALS**

- A See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B List: Submit list of wording, symbols, letter size, and color coding for mechanical identification.
- C Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
- D Product Data: Provide manufacturers catalog literature for each product required.

**PART 2 PRODUCTS**

**2.01 IDENTIFICATION APPLICATIONS**

- A Air Handling Units: Nameplates.
- B Automatic Controls: Tags. Key to control schematic.
- C Control Panels: Nameplates.
- D Dampers: Ceiling tacks, where located above lay-in ceiling.
- E Major Control Components: Nameplates.
- F Piping: Tags.
- G Small-sized Equipment: Tags.
- H Valves: Tags and ceiling tacks where located above lay-in ceiling.

**2.02 NAMEPLATES**

- A Letter Color: White.
- B Letter Height: 1/4 inch.
- C Background Color: Black.
- D Plastic: Comply with ASTM D709.

**2.03 TAGS**

- A Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges.

**2.04 STENCILS**

- A Stencils: With clean cut symbols and letters of following size:
  1. 3/4 to 1-1/4 inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 1/2 inch high letters.
  2. 1-1/2 to 2 inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 3/4 inch high letters.
  3. 2-1/2 to 6 inch Outside Diameter of Insulation or Pipe: 12 inch long color field, 1-1/4 inch high letters.

**2.05 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.
- B Prepare surfaces in accordance with Section 09 91 23 for stencil painting.

**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 91 23.
- D Install plastic pipe markers in accordance with manufacturer's instructions.
- E Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.
- 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.

**END OF SECTION 23 05 53**

**SECTION 23 05 70**  
**MECHANICAL COORDINATION DRAWINGS**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A The Mechanical Contractor shall be responsible for providing 1/4" scale coordination drawings for the entire project, format shall be as stated below.
- B The drawings shall cover above ceiling space, mechanical rooms, electrical rooms and service yards.

**PART 2 PRODUCTS - NOT USED**

**PART 3 EXECUTION**

**3.01 COORDINATION**

- A The Mechanical Contractor shall obtain the architectural, structural, and MEP REVIT models from the Architect. The models will be in REVIT 2022.
- B Where ductwork, piping, or other materials are indicated or required to be installed in the webbing of joists or trusses, the Mechanical Contractor shall confirm the actual joist/truss profile with the Structural Steel supplier prior to finalizing the coordination drawings or fabricating materials.
- C The Mechanical Contractor shall produce drawings that indicate all piping, equipment and ductwork on 1/4 scale drawings. All items shall be drawn to scale, dimensioned and be easily identified. The drawings shall indicate a bottom of duct or bottom of pipe.
- D The Mechanical Contractor shall import a file compatible with Navisworks from the Plumbing Contractor that indicates all piping and plumbing equipment. This includes underground piping. The drawings shall be to scale, dimensioned and clearly identified. The drawings shall indicate bottom of pipe (or centerline) for all equipment or pipes.
- E The Mechanical Contractor shall import a file compatible with Navisworks from the Fire Protection Contractor that indicates all piping, heads, and equipment. The drawings shall be to scale, dimensioned and clearly identified. The drawings shall indicate bottom of pipe (or centerline) for all equipment or pipes.
- F The Mechanical Contractor shall import a file compatible with Navisworks from the Electrical Contractor that indicate all conduits over 2", lights, cable tray, underground duct banks and electrical equipment. The drawings shall be to scale, dimensioned and clearly identified. The drawings shall indicate mounting heights of all equipment.
- G The Mechanical Contractor shall incorporate the Plumbing Contractor's, Fire Protection Contractor's, and the Electrical Contractor's models with his own model to make one overall set of Coordination Drawings for each area. The Mechanical Contractor shall adjust layers, colors, etc., to make the drawing readable.
- H Navisworks shall be used for clash detection. The Mechanical Contractor shall review the overall coordination model for conflicts. If a conflict is found, the Mechanical Contractor shall coordinate revisions to the plans with each sub contractor. There shall be as many iterations as required to produce a clash-free model
- I If any problems cannot be worked out between the Contractors, the Mechanical Contractor shall contact the Engineer. At that time, a meeting with the Engineer and the Architect will be arranged. The Mechanical Contractor shall make the overall coordination model available for the meeting.
- J Once all conflicts have been resolved, the Mechanical Contractor shall provide the Architect and Engineer with a complete set of Coordination Drawings.
- K In addition, the Mechanical Contractor shall send the completed overall coordination drawings to a printer so that the Plumbing, Fire Protection, and Electrical Contractors can order as many copies as they desire (at their expense). The Mechanical Contractor is responsible for providing the Engineer's set, the Architect's set, and the Mechanical Contractor's set(s).
- L The Mechanical Contractor and the Construction Manager are responsible for setting the schedule for this process. The Plumbing Contractor, Fire Protection Contractor, Electrical Contractor and the Architect should approve the schedule.
- M The Coordination Drawings shall be used as the basis for the As-built Drawings. These shall be made available to the Design Team for this purpose.
- N The overall coordination drawings shall be completed prior to any plumbing, mechanical and electrical work beginning. Start of work, including underground work, without completed Coordination Drawings is at the

**Northwoods Park Middle School Addition & Renovation**

Jacksonville, NC

Contractor's risk.

Smith Sinnett / 202203

Onslow County Schools

**END OF SECTION 23 05 70 23 05 70**

**SECTION 23 05 93**  
**TESTING, ADJUSTING, AND BALANCING FOR HVAC**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A Testing, adjustment, and balancing of air systems.
- B Testing, adjustment, and balancing of hydronic and refrigerating systems.
- C Measurement of final operating condition of HVAC systems.
- D Commissioning activities.

**1.02 RELATED REQUIREMENTS**

- A Section 01 91 13 - General Commissioning Requirements: Commissioning requirements that apply to all types of work.
- B Section 23 08 00 - Commissioning of HVAC.

**1.03 REFERENCE STANDARDS**

- A AABC (NSTSB) - AABC National Standards for Total System Balance, 7th Edition; 2016.
- B ASHRAE Std 111 - Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems; 2008.

**1.04 SUBMITTALS**

- A Installer Qualifications: Submit name of adjusting and balancing agency and TAB supervisor for approval within 30 days after award of Contract.
- 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 to the Commissioning Authority.
  - 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. Discussion of what notations and markings will be made on the duct and piping drawings during the process.
    - d. Final test report forms to be used.
    - e. Detailed step-by-step procedures for TAB work for each system and issue, including:
      - 1) Terminal flow calibration (for each terminal type).
      - 2) Diffuser proportioning.
      - 3) Branch/submain proportioning.
      - 4) Total flow calculations.
      - 5) Rechecking.
      - 6) Diversity issues.
    - f. Expected problems and solutions, etc.
    - g. Criteria for using air flow straighteners or relocating flow stations and sensors; analogous explanations for the water side.
    - h. 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.
    - i. Specific procedures that will ensure that both air and water side are operating at the lowest possible pressures and methods to verify this.
    - j. Confirmation of understanding of the outside air ventilation criteria under all conditions.
    - k. Method of verifying and setting minimum outside air flow rate will be verified and set and for what level (total building, zone, etc.).
    - l. Methods for making coil or other system plant capacity measurements, if specified.
    - m. Time schedule for deferred or seasonal TAB work, if specified.
    - n. False loading of systems to complete TAB work, if specified.



- o. Exhaust fan balancing and capacity verifications, including any required room pressure differentials.
  - p. Procedures for field technician logs of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests (scope and frequency).
  - q. Procedures for formal deficiency reports, including scope, frequency and distribution.
- C Field Logs: Submit at least twice a week to the Commissioning Authority.
- D Control System Coordination Reports: Communicate in writing to the controls installer all setpoint and parameter changes made or problems and discrepancies identified during TAB that affect, or could affect, the control system setup and operation.
- E Progress Reports.
- F Final Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
- 1. Submit to the the Commissioning Authority within two weeks after completion of testing, adjusting, and balancing.
  - 2. Revise TAB plan to reflect actual procedures and submit as part of final report.
  - 3. 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.
  - 4. Include actual instrument list, with manufacturer name, serial number, and date of calibration.
  - 5. Form of Test Reports: Where the TAB standard being followed recommends a report format use that; otherwise, follow ASHRAE Std 111.
  - 6. 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.
- B Begin work after completion of systems to be tested, adjusted, or balanced and complete work prior to Substantial Completion of the project.
- C Where HVAC systems and/or components interface with life safety systems, including fire and smoke detection, alarm, and control, coordinate scheduling and testing and inspection procedures with the authorities having jurisdiction.
- D 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](http://www.aabc.com/#sle); upon completion submit AABC National Performance Guaranty.
    - b. NEBB, National Environmental Balancing Bureau: [www.nebb.org/#sle](http://www.nebb.org/#sle).
- E 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:
- 1. Systems are started and operating in a safe and normal condition.
  - 2. Temperature control systems are installed complete and operable.
  - 3. Proper thermal overload protection is in place for electrical equipment.
  - 4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
  - 5. Duct systems are clean of debris.
  - 6. Fans are rotating correctly.
  - 7. Fire and volume dampers are in place and open.
  - 8. Air coil fins are cleaned and combed.
  - 9. Access doors are closed and duct end caps are in place.
  - 10. Air outlets are installed and connected.
  - 11. Duct system leakage is minimized.

12. Proper strainer baskets are clean and in place.
13. Service and balance valves are open.

B Submit field reports. Report defects and deficiencies that will or could prevent proper system balance.

C Beginning of work means acceptance of existing conditions.

### 3.03 PREPARATION

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

1. Require attendance by all installers whose work will be tested, adjusted, or balanced.

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

C Provide additional balancing devices as required.

### 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 Field Logs: Maintain written logs including:

1. Running log of events and issues.
2. Discrepancies, deficient or uncompleted work by others.
3. Contract interpretation requests.
4. Lists of completed tests.

B Ensure recorded data represents actual measured or observed conditions.

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

D Mark on drawings the locations where traverse and other critical measurements were taken and cross reference the location in the final report.

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

F 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 Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.

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

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

### 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 gages 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 COMMISSIONING

- A See Sections 01 91 13 - General Commissioning Requirements and 23 08 00 for additional requirements.
- B Perform prerequisites prior to starting commissioning activities.
- C Fill out Prefunctional Checklists for:
  - 1. Air side systems.
  - 2. Water side systems.
- D Furnish to the Commissioning Authority, upon request, any data gathered but not shown in the final TAB report.
- E Re-check a random sample equivalent to 25 percent of the final TAB report data as directed by Commissioning Authority.
  - 1. Original TAB agency shall execute the re-checks, witnessed by the Commissioning Authority.
  - 2. Use the same test instruments as used in the original TAB work.
  - 3. Failure of more than 10 percent of the re-checked items of a given system shall result in the rejection of the system TAB report; rebalance the system, provide a new system TAB report, and repeat random re-checks.
  - 4. For purposes of re-check, failure is defined as follows:
    - a. Air Flow of Supply and Return: Deviation of more than 10 percent of instrument reading.
    - b. Minimum Outside Air Flow: Deviation of more than 20 percent of instrument reading; for inlet vane or VFD OSA compensation system using linear proportional control, deviation of more than 30 percent at intermediate supply flow.
    - c. Temperatures: Deviation of more than one degree F.
    - d. Air and Water Pressures: Deviation of more than 10 percent of full scale of test instrument reading.
    - e. Sound Pressures: Deviation of more than 3 decibels, with consideration for variations in background noise.
  - 5. For purposes of re-check, a whole system is defined as one in which inaccuracies will have little or no impact on connected systems; for example, the air distribution system served by one air handler or the hydronic chilled water supply system served by a chiller or the condenser water system.
- F In the presence of the Commissioning Authority, verify that:
  - 1. Final settings of all valves, splitters, dampers and other adjustment devices have been permanently marked.
  - 2. The air system is being controlled to the lowest possible static pressure while still meeting design loads, less diversity; this shall include a review of TAB methods, established control setpoints, and physical verification of at least one leg from fan to diffuser having all balancing dampers wide open and that during full cooling of all terminal units taking off downstream of the static pressure sensor, the terminal unit on the critical leg has its damper 90 percent or more open.
  - 3. The water system is being controlled to the lowest possible pressure while still meeting design loads, less diversity; this shall include a review of TAB methods, established control setpoints, and physical verification of at least one leg from the pump to the coil having all balancing valves wide open and that during full cooling the cooling coil valve of that leg is 90 percent or more open.

### 3.09 SCOPE

- A Test, adjust, and balance the following:
  - 1. Packaged Roof Top Heating/Cooling Units.
  - 2. Packaged Terminal Air Conditioning Units.
  - 3. Unit Air Conditioners.

4. Air Handling Units.
5. Fans.
6. Air Inlets and Outlets.

**3.10 MINIMUM DATA TO BE REPORTED**

- A Electric Motors:
1. Manufacturer.
  2. Model/Frame.
  3. HP/BHP.
  4. Phase, voltage, amperage; nameplate, actual, no load.
  5. RPM.
  6. Service factor.
  7. Starter size, rating, heater elements.
  8. Sheave Make/Size/Bore.
- B V-Belt Drives:
1. Identification/location.
  2. Required driven RPM.
  3. Driven sheave, diameter and RPM.
  4. Belt, size and quantity.
  5. Motor sheave diameter and RPM.
- C Air Cooled Condensers:
1. Identification/number.
  2. Location.
  3. Manufacturer.
  4. Model number.
  5. Serial number.
  6. Entering DB air temperature, design and actual.
  7. Leaving DB air temperature, design and actual.
  8. Number of compressors.
- D Cooling Coils:
1. Identification/number.
  2. Location.
  3. Service.
  4. Manufacturer.
  5. Air flow, design and actual.
  6. Entering air DB temperature, design and actual.
  7. Entering air WB temperature, design and actual.
  8. Leaving air DB temperature, design and actual.
  9. Leaving air WB temperature, design and actual.
  10. Entering water temperature, design and actual.
  11. Leaving water temperature, design and actual.
  12. Saturated suction temperature, design and actual.
  13. Air 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 Air Moving Equipment:
1. Location.
  2. Manufacturer.
  3. Model number.
  4. Serial number.
  5. Arrangement/Class/Discharge.
  6. Air flow, specified and actual.
  7. Return air flow, specified and actual.
  8. Outside air flow, specified and actual.
  9. Total static pressure (total external), specified and actual.
  10. Inlet pressure.
  11. Discharge pressure.
  12. Sheave Make/Size/Bore.
  13. Number of Belts/Make/Size.
  14. Fan RPM.
- G Return Air/Outside Air:
1. Identification/location.
  2. Design air flow.
  3. Actual air flow.
  4. Design return air flow.
  5. Actual return air flow.
  6. Design outside air flow.
  7. Actual outside air flow.
  8. Return air temperature.
  9. Outside air temperature.
  10. Required mixed air temperature.
  11. Actual mixed air temperature.
- H Exhaust Fans:
1. Location.
  2. Manufacturer.
  3. Model number.
  4. Serial number.
  5. Air flow, specified and actual.
  6. Total static pressure (total external), specified and actual.
  7. Inlet pressure.
  8. Discharge pressure.
  9. Sheave Make/Size/Bore.
  10. Number of Belts/Make/Size.
  11. Fan RPM.
- I Duct Traverses:
1. System zone/branch.
  2. Duct size.
  3. Area.
  4. Design velocity.
  5. Design air flow.
  6. Test velocity.
  7. Test air flow.
  8. Duct static pressure.
  9. Air temperature.

10. Air correction factor.
- J Duct Leak Tests:
1. Description of ductwork under test.
  2. Duct design operating pressure.
  3. Duct design test static pressure.
  4. Duct capacity, air flow.
  5. Maximum allowable leakage duct capacity times leak factor.
  6. Test apparatus:
    - a. Blower.
    - b. Orifice, tube size.
    - c. Orifice size.
    - d. Calibrated.
  7. Test static pressure.
  8. Test orifice differential pressure.
  9. Leakage.
- K Flow Measuring Stations:
1. Identification/number.
  2. Location.
  3. Size.
  4. Manufacturer.
  5. Model number.
  6. Serial number.
  7. Design Flow rate.
  8. Design pressure drop.
  9. Actual/final pressure drop.
  10. Actual/final flow rate.
  11. Station calibrated setting.
- L Air Distribution Tests:
1. Air terminal number.
  2. Room number/location.
  3. Terminal type.
  4. Terminal size.
  5. Area factor.
  6. Design velocity.
  7. Design air flow.
  8. Test (final) velocity.
  9. Test (final) air flow.
  10. Percent of design air flow.

**END OF SECTION 23 05 93**

**SECTION 23 07 13**  
**DUCT INSULATION**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A Duct insulation.
- B Duct liner.
- C Jacketing and accessories.

**1.02 REFERENCE STANDARDS**

- A ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2021a.
- B ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2021.
- C ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2023.
- D ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications; 2013 (Reapproved 2019).
- E ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation; 2014 (Reapproved 2019).
- F ASTM C916 - Standard Specification for Adhesives for Duct Thermal Insulation; 2020.
- G ASTM C1071 - Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material); 2019.
- H ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2018b.
- I ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2022a, with Editorial Revision (2023).
- J ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi; 2015, with Editorial Revision (2021).
- K UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

**1.03 SUBMITTALS**

- A Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations. Include the following information:
  - 1. Schedule indicating insulation type, thickness, and location for each service
  - 2. Density
  - 3. Compressive Strength
  - 4. "k" value at 75 deg F
  - 5. Nominal "R" value
  - 6. Flame spread rating
- B Manufacturer's Instructions: Indicate installation procedures necessary to ensure acceptable workmanship and that installation standards will be achieved.

**1.04 QUALITY ASSURANCE**

- A Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section with not less than three years of documented experience.
- B Applicator Qualifications: Company specializing in performing the type of work specified in this section, documented experience and approved by manufacturer.
- C Before installing insulation, build mockups for each type of insulation and finish listed below to demonstrate quality of insulation application and finishes. Build mockups in the location indicated or, if not indicated, as directed by Owner. Use materials indicated for the completed Work. Mockups shall include piping insulation, ductwork insulation and equipment insulation.
- D All the ductwork and piping in pump rooms, mechanical rooms and equipment rooms including areas without ceilings is to be considered as exposed piping or ductwork. This also includes penthouses, interstitial spaces, and crawl spaces, where applicable.

**1.05 DELIVERY, STORAGE, AND HANDLING**

- A Accept materials on site in original factory packaging, labelled with manufacturer's identification, including product density and thickness.
- B Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

**1.06 FIELD CONDITIONS**

- A Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
- B Maintain temperature during and after installation for minimum period of 24 hours.
- C Insulation shall not be installed until all testing and inspection of pipe, duct, vessel, etc. has been completed and approved by Engineer/Owner's representative.

**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, UL 723, ASTM E84, or UL 723. These ratings must be as tested on composite of insulation, jacket or facing, and adhesive. Components such as adhesives, mastics, and cements must meet the same individual ratings as minimum requirements.

**2.02 GLASS FIBER, FLEXIBLE**

- A Manufacturer:
  - 1. CertainTeed Corporation
  - 2. Johns Manville
  - 3. Knauf Insulation
  - 4. Owens Corning Corporation
  - 5. Or Approved Equal
- B Insulation: ASTM C553; flexible, noncombustible blanket.
  - 1. K value: 0.36 at 75 degrees F, when tested in accordance with ASTM C518.
  - 2. Maximum Service Temperature: 1,200 degrees F.
  - 3. Maximum Water Vapor Absorption: 5.0 percent by weight.
- C Vapor Barrier Jacket:
  - 1. Kraft paper with glass fiber yarn and bonded to aluminized film.
  - 2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
  - 3. Secure with pressure-sensitive tape.
- D Vapor Barrier Tape:
  - 1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure-sensitive rubber-based adhesive.
- E Indoor Vapor Barrier Mastic:
  - 1. Manufacturers:
    - a. Childers CP-35
    - b. Harcast Seal-Tack AF
- F Tie Wire: Annealed steel, 16 gauge, 0.0508 inch diameter.

**2.03 GLASS FIBER, RIGID**

- A Manufacturer:
  - 1. CertainTeed Corporation
  - 2. Johns Manville
  - 3. Knauf Insulation
  - 4. Owens Corning Corporation
  - 5. Or Approved Equal
- B Insulation: ASTM C612; rigid, noncombustible blanket.
  - 1. K Value: 0.24 at 75 degrees F, when tested in accordance with ASTM C518.
  - 2. Maximum Service Temperature: 450 degrees F.
  - 3. Maximum Water Vapor Absorption: 5.0 percent.
  - 4. Maximum Density: 8.0 pcf.



- C Vapor Barrier Jacket:
  - 1. Kraft paper with glass fiber yarn and bonded to aluminized film.
  - 2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
  - 3. Secure with pressure-sensitive tape.
- D Vapor Barrier Tape:
  - 1. Manufacturers:
    - a. 3M
    - b. Polyguard
    - c. Shurtape
  - 2. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure-sensitive rubber-based adhesive.
- E Protective Coating:
  - 1. Manufacturers:
    - a. Design Polymerics; DP 2510 Water Based, Low VOC, Duct Liner Protective Coating:
- F Indoor Vapor Barrier Finish:
  - 1. Cloth: Untreated; 9 oz/sq yd weight, glass fabric.
  - 2. Vinyl emulsion type acrylic, compatible with insulation, white color.

#### 2.04 POLYISOCYANURATE INSULATION BOARD

- A Manufacturer:
  - 1. Dyplast
  - 2. Rmax
  - 3. Johns Manville
  - 4. Or Approved Equal
- B Insulation:
  - 1. Flat Foam Insulation with Heavy Duty Fiber-Reinforced Facers: closed-cell polyisocyanurate foam core laminated to extra durable heavy duty fiber-reinforced facers on both sides; conforming to ASTM C 1289, Type II, Class 2.
  - 2. Blowing Agent: Zero ODP, 3rd generation.
  - 3. Thickness 2.00 inch, R Value 11.4, flute spanability 4-3/8 inches
  - 4. 25/450 flame/smoke spread rating
- C Vapor Barrier Jacket:
  - 1. Asphalt Bitumen: ASTM D 312, Type III, or Type IV.
- D Vapor Barrier Tape:
  - 1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.

#### 2.05 JACKETING AND ACCESSORIES

- A Canvas Jacket: UL listed 6 oz/sq yd plain weave cotton fabric treated with dilute fire-retardant lagging adhesive.
  - 1. Lagging Adhesive:
    - a. Manufacturers:
      - 1) Design Polymerics; DP 3050 Water Based, Zero VOC, Premium Quality, Lagging Adhesive, and Vapor Retarder
      - 2) Childers CP-35
    - b. Compatible with insulation.
- B Mineral Fiber (Outdoor) Jacket: Asphalt impregnated and coated sheet, 50 lb/square.
- C Aluminum Jacket:
  - 1. Comply with ASTM B209/B209M, Temper H14, minimum thickness of 0.016 inch with factory-applied polyethylene and kraft paper moisture barrier on the inside surface.
  - 2. Thickness: 0.016 inch sheet.
  - 3. Finish: Embossed.
  - 4. Joining: Longitudinal slip joints and 2 inch laps.
  - 5. Fittings: 0.016 inch thick die-shaped fitting covers with factory-attached protective liner.

6. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.

## 2.06 FIRE BARRIER DUCT WRAP

- A Two-layer wrap for grease ducts rated as a shaft alternative per ASTM E 2336. Zero clearance to combustible throughout the entire enclosure system.
- B High-temperature fibrous thermal insulation blanket encapsulated in a fiberglass-reinforced aluminized polyester foil. Duct Wrap density shall be nominal 6 pcf and have a nominal 1-1/2" thickness. The fiber blanket shall have a continuous use limit of 1000°C.
- C When installed in two layers, shall meet the criteria of ASTM E 2336 Standard Test Methods for Fire Resistive Grease Duct Enclosure Systems.
- D Smoke Developed Index and Flame Spread Index of the bare blanket, and of the foil encapsulated blanket shall be 0/0 per ASTM E 84. The foil encapsulation shall be bonded to the core blanket material.
- E Manufacturers:
  1. 3M Fire Barrier Duct Wrap 615+
  2. Unifrax Fyrewrap
  3. Or Approved Equal

## 2.07 DUCT LINER

- A Manufacturers:
  1. Armacell LLC
  2. CertainTeed Corporation
  3. Ductmate Industries, Inc, a DMI Company
  4. K-Flex
  5. Aerofoam
  6. Johns Manville
  7. Knauf Insulation
  8. Owens Corning Corporation
  9. Or Approved Equal
- B Elastomeric Foam Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1, in sheet form.
  1. Minimum Service Temperature: Minus 40 degrees F.
  2. Maximum Service Temperature: 180 degrees F.
  3. Fungal Resistance: No growth when tested according to ASTM G21.
  4. Bacteria Resistance: No growth when tested according to ASTM G22.
  5. Apparent Thermal Conductivity: Maximum of 0.28 at 75 degrees F.
  6. Minimum Noise Reduction Coefficients:
    - a. 1 inch Thickness: 0.40.
    - b. 1-1/2 inches Thickness: 0.50.
    - c. 2 inch Thickness: 0.60.
  7. Erosion Resistance: Does not show evidence of breaking away, flaking off, or delamination at velocities of 10,000 fpm when tested in accordance with ASTM C1071.
  8. Connection: Waterproof vapor barrier adhesive.
  9. Made with EPA registered Microban® antimicrobial product protection.
- C Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation. Comply with ASTM C916.
- D Polyester Insulation:
  1. Minimum Service Temperature: Minus 40 degrees F.
  2. Maximum Service Temperature: 220 degrees F.
  3. Fungal Resistance: No growth when tested according to ASTM G21.
  4. Bacteria Resistance: No growth when tested according to ASTM G22.
  5. Apparent Thermal Conductivity: Maximum of 0.28 at 75 degrees F.
  6. Minimum Noise Reduction Coefficients:
    - a. 1 inch Thickness: 0.6
    - b. 1.5 inch Thickness: 0.7

7. Erosion Resistance: Does not show evidence of breaking away, flaking off, or delamination at velocities of 10,000 fpm per ASTM C1071.
- E Adhesive: Waterproof, fire-retardant type, ASTM C916.
  1. Manufacturers:
    - a. Design Polymeric; DP 2502 Water Based, Low VOC, Duct Liner Adhesive
    - b. Vimasco Corporation
    - c. ITW Ultratack
    - d. RCD #5 Ductliner Adhesive
- F Liner Fasteners: Galvanized steel, self-adhesive pad with integral head.
  1. Manufacturers:
    - a. Elgen Manufacturing Company, Inc; Peel and Press Insulation Hangers

### **PART 3 EXECUTION**

#### **3.01 EXAMINATION**

- A Test ductwork for design pressure prior to applying insulation materials.
- B Verify that surfaces are clean, foreign material removed, and dry.

#### **3.02 INSTALLATION**

- A Install in accordance with manufacturer's instructions.
- B Insulate all supply diffusers and ducted return grilles with 2" R6 Duct Wrap. Cut diffusers so there is a folder 2" lap on all four sides. Tape with FSK tape where insulated flex meets duct insulation so there are no raw edges of fiberglass.
- C Use of duct liner shall be limited to transfer ducts only.
- D Install multiple layers of insulation with longitudinal and end seams staggered.
- E Install insulation with least number of joints practical.
- F The duct liner ends of all transfer ducts shall receive a channel nosing - 1" x liner thickness x 1", mechanically secured to the sheet metal duct in accordance with NAIMA fabrication standards.
- G Insulated Ducts Conveying Air Below Ambient Temperature:
  1. Insulation on all pipes or ducts conveying air or liquids below the ambient temperature is required to have a continuous vapor barrier. On all insulation with a vapor barrier, seal the joints, duct wrap seams, vapor retarder (ASJ) film seams and penetrations in insulation at hangers, supports, anchors, and other projections with a vapor-barrier coating/mastic as specified in the individual insulation sections.
  2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier coating/mastic.
  3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
  4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
  5. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
- H Ducts Exposed in Mechanical Equipment Rooms or Finished Spaces: Provide rigid fiberglass board insulation and finish with canvas jacket sized for finish painting.
- I Exterior Applications: Provide rigid polyisocyanurate board insulation with vapor barrier jacket. Provide rigid polyiso board insulation and cover with with calked aluminum jacket with seams located on bottom side of horizontal duct section.
- J External Duct Wrap Insulation Application:
  1. Secure insulation with vapor barrier with wires and seal jacket joints with vapor barrier adhesive or tape to match jacket.
  2. Install without sag on underside of duct. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift duct off trapeze hangers and insert spacers. Spacers shall be heavy density insulation board material. Refer to MICA 8th edition Plate 3-640.
  3. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.
  4. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.

**3.03 SCHEDULES**

- A All supply, outside air, and return air ductwork shall be completely insulated, unless otherwise noted on the plans. Insulation shall completely cover flexible connections. Insulation shall be minimum 2.5 inch thick or the thickness required to meet the R-values below.
- B All insulation within the building envelope, except in the attic (where applicable), shall have a minimum R-value of 6.0 based on installed thickness. Any insulation wrap or board installed outside the building envelope or in an attic, shall have a minimum R-value of 8.0 based on installed thickness.
- C All exhaust duct associated with any unit having energy recovery (enthalpy wheel, enthalpy plate, run around loop, etc.) shall be insulated to R6.0 inside the building and R8.0 outside the building.
- D Exhaust and Relief Ducts Within 10 ft of Exterior Openings or Building Envelope Penetrations: minimum R-value of 6.0 based on installed thickness.

**END OF SECTION 23 07 13**

**SECTION 23 07 19**  
**HVAC PIPING INSULATION**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A Piping insulation.
- B Flexible removable and reusable blanket insulation.
- C Jacketing and accessories.

**1.02 RELATED REQUIREMENTS**

- A Section 07 84 00 - Firestopping.

**1.03 REFERENCE STANDARDS**

- A ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2021a.
- B ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus; 2019, with Editorial Revision (2023).
- C ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement; 2007 (Reapproved 2019).
- D ASTM C449 - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement; 2007 (Reapproved 2019).
- E ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2023.
- F ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation; 2022a.
- G ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel; 2008 (Reapproved 2018).
- H ASTM C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation; 2023.
- I ASTM C1423 - Standard Guide for Selecting Jacketing Materials for Thermal Insulation; 2021.
- J ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2018b.
- K ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2022a, with Editorial Revision (2023).
- L ASTM G153 - Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials; 2013 (Reapproved 2021).
- M SAE AMS3779 - Tape, Adhesive, Pressure-Sensitive Thermal Radiation Resistant, Aluminum Coated Glass Cloth; 2016b.
- N MICA - Midwest Insulation Contractors Association National Commercial & Industrial Insulation Standards; 8th Edition.
- O UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

**1.04 SUBMITTALS**

- A Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations. Provide the following information:
  - 1. Schedule indicating insulation type, thickness, and location for each service (equipment, duct, and pipe with size).
  - 2. Density
  - 3. Compressive Strength
  - 4. "k" value at 75 deg F
  - 5. Nominal "R" value
  - 6. Mean temperature range
  - 7. Flame spread rating
- B Shop Drawings: Show details for the following:
  - 1. Application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
  - 2. Attachment and covering of heat tracing inside insulation.
  - 3. Insulation application at pipe expansion joints for each type of insulation.
  - 4. Insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.

5. Application of field-applied jackets.

- C Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.
- D Provide plates from MICA 8th edition manual for each insulation system on the project as part of the submittals. The plates for each system shall be filled out by the insulating contractor for each product being used.

#### 1.05 QUALITY ASSURANCE

- A Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than three years of documented experience.
- B Applicator Qualifications: Company specializing in performing the type of work specified in this section with minimum five years of experience.

#### 1.06 DELIVERY, STORAGE, AND HANDLING

- A Accept materials on site, labeled with manufacturer's identification, product density, and thickness.
- B Store insulation in original wrapping and protect from weather and construction traffic. Protect insulation against dirt, water, chemical, and mechanical damage.

#### 1.07 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.
- C Insulation shall not be installed until all testing and inspection of pipe, duct, vessel, etc. has been completed and approved by Engineer/Owner's representative.
- D Replace insulation damaged by either moisture or other means. Insulation which has been wet, whether dried or not, is considered damaged. Make repairs where condensation is caused by improper installation of insulation. Also replace any materials damaged by the condensation.

### 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, UL 723, 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. Manson Insulation
  - 6. Or Approved Equal
- B Insulation: ASTM C547 and ASTM C795; rigid molded, noncombustible.
  - 1. K Value: ASTM C177, 0.24 at 75 degrees F.
  - 2. Maximum Service Temperature: 850 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.
- E Vapor Barrier Lap Adhesive: Compatible with insulation.
- F Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.
- G Fibrous Glass Fabric:
  - 1. Cloth: Untreated; 9 oz/sq yd weight.
  - 2. Blanket: 1.0 pcf density.
  - 3. Weave: 5 by 5.
- H Indoor Vapor Barrier Finish:
  - 1. Cloth: Untreated; 9 oz/sq yd weight.
  - 2. Vinyl emulsion type acrylic, compatible with insulation, white color.

- I Outdoor Vapor Barrier Mastic: Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.
- J Insulating Cement: ASTM C449.

**2.03 FLEXIBLE ELASTOMERIC CELLULAR INSULATION**

- A Manufacturers:
  - 1. Aeroflex USA, Inc
  - 2. Armacell LLC
  - 3. K-Flex USA LLC
  - 4. Or Approved Equal
- B Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1; use molded tubular material wherever possible.
  - 1. Minimum Service Temperature: Minus 40 degrees F.
  - 2. Maximum Service Temperature: 180 degrees F.
  - 3. Connection: Waterproof vapor barrier adhesive.
- C Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

**2.04 JACKETING AND ACCESSORIES**

- A PVC Plastic.
  - 1. Manufacturers:
    - a. Johns Manville Corporation
    - b. Speedline Corporation
    - c. Knauf Insulation
    - d. Proto PVC Corp
    - e. Or Approved Equal
  - 2. Jacket: One piece molded type fitting covers and sheet material, off-white color.
    - a. Minimum Service Temperature: 0 degrees F.
    - b. Maximum Service Temperature: 150 degrees F.
    - c. Moisture Vapor Permeability: 0.002 perm inch, maximum, when tested in accordance with ASTM E96/E96M.
    - d. Thickness: 30 mil.
    - e. Connections: Brush on welding adhesive.
  - 3. Covering Adhesive Mastic: Compatible with insulation.
  - 4. Color: Jacketing shall be color coded per the following:
    - a. Hot Water Supply/Return      Medium Red
    - b. Makeup Water                              Green
    - c. Refrigerant                              Gray
- B Canvas Jacket: UL listed 6 oz/sq yd plain weave cotton fabric treated with dilute fire-retardant lagging adhesive.
  - 1. Lagging Adhesive: Compatible with insulation.
    - a. Manufacturers:
      - 1) Vimasco Corporation:
      - 2) GLT Products
- C Aluminum Jacket:
  - 1. Manufacturers:
    - a. Alumaguard.
    - b. ITW.
  - 2. Comply with ASTM B209/B209M, Temper H14, minimum thickness of 0.016 inch with factory-applied polyethylene and kraft paper moisture barrier on the inside surface.
  - 3. Thickness: 0.016 inch sheet.
  - 4. Finish: Embossed.
  - 5. Joining: Longitudinal slip joints and 2 inch laps.
  - 6. Fittings: 0.016 inch thick die-shaped fitting covers with factory-attached protective liner.
  - 7. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.

- D Reinforced Tape:
  - 1. FSK tape suitable for sealing seams between insulation, insulated pipe bends, and fittings resulting in a tight, smooth surface without wrinkles.
  - 2. Comply with UL 723, ASTM E84.
  - 3. Moisture Vapor Permeability: 0.00 perm inch, when tested in accordance with ASTM E96/E96M.
  - 4. Finish: Match insulation.
- E Plain Foil Tape:
  - 1. Aluminum foil with pressure-sensitive adhesive on paper release liner.

### **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 and the MICA manual 8th edition. In cases of conflict, the more stringent instructions shall apply.
- B Where existing piping insulation is either removed or damaged during construction, it shall be reinsulated per these specifications.
- C Where insulation thickness exceeds 3 inches, the insulation shall be two layers. Secure first layer before installing the next layer and stagger the joints.
- D Install multiple layers of insulation with longitudinal and end seams staggered.
- E Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- F Install insulation with least number of joints practical.
- G Exposed Piping: Locate insulation and cover seams in least visible locations.
- H Insulated Pipes Conveying Fluids Below Ambient Temperature:
  - 1. Insulate entire system, including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
  - 2. Insulation on all pipes or ducts conveying air or liquids below the ambient temperature is required to have a continuous vapor barrier. On all insulation with a vapor barrier, seal the joints, duct wrap seams, vapor retarder (ASJ) film seams and penetrations in insulation at hangers, supports, anchors, and other projections with a vapor-barrier coating/mastic as specified in the individual insulation sections.
  - 3. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier coating/mastic.
  - 4. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
  - 5. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- I For hot piping conveying fluids over 120 degrees F, insulate flanges and unions at equipment.
- J Glass Fiber Insulated Pipes Conveying Fluids Above Ambient Temperature:
  - 1. Provide standard jackets, with vapor barrier, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples.
  - 2. Insulate fittings and joints with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
- K Inserts and Shields:
  - 1. Shields: Galvanized steel, 20 gauge, one half the circumference of the insulation, and a minimum of 12 inches long, between pipe hangers or pipe hanger rolls and inserts.
  - 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.
- L Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, see Section 07 84 00.
- M Pipe Exposed in Mechanical Equipment Rooms: Finish with PVC jacket color coded to piping system. Refer to 23 05 53 for colors.
- N Pipe Exposed in Finished Spaces: Finish with canvas jacket sized for finish painting. Canvas shall be coated twice with Foster fireproof lagging to ensure specified flame and smoke spread ratings.
- O For refrigerant line sets and condensate piping exposed to view serving wall mounted units, provide lineset cover system. Speedichannel by DiversiTech, Hide-A-Line by DuctlessAire, or equivalent by Inaba Denko.
- P Exterior Applications: Provide vapor barrier jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor barrier cement. Provide with 0.016 inch aluminum rolled jacket. Cover with aluminum jacket with aluminum bands 12 inches on center and at each butt joint located on bottom side of horizontal piping. Fittings shall be covered with two piece factory fabricated "ELL-JACS."
- Q Buried Piping: Provide factory-fabricated assembly with inner all-purpose service jacket with self-sealing lap, and asphalt impregnated open mesh glass fabric, with 1 mil, 0.001 inch thick aluminum foil sandwiched between three layers of bituminous compound; outer surface faced with polyester film.
- R Heat Traced Piping: All piping exposed outdoors shall be wrapped with electric trace before insulation is applied. Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer. Cover with aluminum jacket with seams located on bottom side of horizontal piping.
- S All exposed piping surfaces, insulation, supports, etc., shall be painted with two coats of oil base paint. Color shall be selected by the Owner.
- T Insulation systems shall be installed per the applicable plate from the MICA manual 8th edition:
  1. Pre-formed Pipe Insulation Single Layer Construction: Plate 1-100
  2. Flexible Foam Insulation: Plate 1-200
  3. Field applied Metal Jacketing: Plate 1-400
  4. Non-metallic sealed jacketing systems: PVC, etc: Plate 1-510
  5. Split Ring Hangers: Plate 1-600
  6. Clevis Hanger with High Density Inserts: Plate 1-610
  7. Pre-Insulated Pipe Support, Standoff Clamp: Plate 1-640
  8. Vapor Stop (Dam) - Pipe: Plate 1-660
  9. Refrigerant and Low Temperature: Plate 1-801
  10. Traced Piping: Plate 1-900
  11. Pre-formed Elbow Insulation: Plate 2-100
  12. Mechanical Fitting Field Fabricated: Plate 2-116
  13. Pre-formed or Fabricated Tee Insulation: Plate 2-120
  14. Field or Factory-Fabricated Valve Insulation: Plate 2-130
  15. In-line Flange Insulation Built-up and Beveled: Plate 2-135
  16. Flexible Foam Fittings: 90s and 45s: Plate 2-200
  17. Flexible Foam Fittings, Ts: 2-220
  18. Flexible Foam Ts: Plate 2-225
  19. PVC/Insert Valve Insulation: Plate 2-530
  20. PVC/Insert Mechanical Coupling on In-line Flange: Plate 2-535
  21. Non-metallic Jackets: Fitting and Valve Insulation Sealed Jacketing Systems: Plate 2-536
  22. PVC End Cap Over Insulation: 2-540
  23. Vapor Stop (Dam) - Fittings: Plate 2-660
  24. Large Diameter Vessels Block and Blanket Insulation: Plate 4-100
  25. Small Diameter Vessels: Plate 4-120
  26. Large Diameter Horizontal Vessels: Plate 4-140
  27. Vessels, Flexible Foam Sheets: 4-200

28. Flexible Foam for Low Temperature Equipment: 4-210

29. Vapor Stop (Dam) - Equipment: 4-660

**3.03 SCHEDULE**

**A Hot Water:**

1. Piping 1.5 inches in diameter and smaller shall have minimum 1.5 inch thick insulation.
2. Piping 2.0 inches or larger in diameter shall have minimum 2.0 inch thick insulation.
3. Hot Water Piping exposed to outdoor air shall have minimum 2.5 inch thick insulation.
4. Hot water piping insulation shall be fiberglass.

**B Makeup Water (from domestic water):**

1. Insulate all makeup water lines with 0.5" thick closed cell insulation.

**C Condensate**

1. Condensate lines shall be insulated with 1.0 inch thick closed cell insulation. The insulation shall extend from the connection on the unit until it either terminates at a floor drain or other indirect waste receptor, or turns underground.

**D Refrigerant**

1. Refrigerant lines shall be insulated with 1.5 inch thick closed cell elastomeric foam insulation. Both gas and liquid lines should be insulated.

**END OF SECTION 23 07 19**

**SECTION 23 08 00**  
**COMMISSIONING OF HVAC**

**PART 1 GENERAL**

**1.01 SUMMARY**

- A See Section 01 91 13 - General Commissioning Requirements for overall objectives; comply with the requirements of Section 01 91 13.
- B This section covers the Contractor's responsibilities for commissioning; each subcontractor or installer responsible for the installation of a particular system or equipment item to be commissioned is responsible for the commissioning activities relating to that system or equipment item.
- C The Commissioning Authority (CA) directs and coordinates all commissioning activities and provides Prefunctional Checklists and Functional Test Procedures for Contractor's use.
- D The entire HVAC system is to be commissioned, including commissioning activities for the following specific items:
  - 1. Control system.
  - 2. Major and minor equipment items.
  - 3. Other equipment and systems explicitly identified elsewhere in Contract Documents as requiring commissioning.
- E The Prefunctional Checklist and Functional Test requirements specified in this section are in addition to, not a substitute for, inspection or testing specified in other sections.

**1.02 REFERENCE STANDARDS**

- A ASHRAE Guideline 1.1 - HVAC&R Technical Requirements for the Commissioning Process; 2007, with Errata (2012).

**1.03 SUBMITTALS**

- A Updated Submittals: Keep the Commissioning Authority informed of all changes to control system documentation made during programming and setup; revise and resubmit when substantial changes are made.
- B Draft Prefunctional Checklists and Functional Test Procedures for Control System: Detailed written plan indicating the procedures to be followed to test, checkout and adjust the control system prior to full system Functional Testing; include at least the following for each type of equipment controlled:
  - 1. System name.
  - 2. List of devices.
  - 3. Step-by-step procedures for testing each controller after installation, including:
    - a. Process of verifying proper hardware and wiring installation.
    - b. Process of downloading programs to local controllers and verifying that they are addressed correctly.
    - c. Process of performing operational checks of each controlled component.
    - d. Plan and process for calibrating valve and damper actuators and all sensors.
    - e. Description of the expected field adjustments for transmitters, controllers and control actuators should control responses fall outside of expected values.
  - 4. Copy of proposed log and field checkout sheets to be used to document the process; include space for initial and final read values during calibration of each point and space to specifically indicate when a sensor or controller has "passed" and is operating within the contract parameters.
  - 5. Description of the instrumentation required for testing.
  - 6. Indicate what tests on what systems should be completed prior to TAB using the control system for TAB work. Coordinate with the Commissioning Authority and TAB contractor for this determination.
- C Startup Reports, Prefunctional Checklists, and Trend Logs: Submit for approval of Commissioning Authority.
- D HVAC Control System O&M Manual Requirements. In addition to documentation specified elsewhere, compile and organize at minimum the following data on the control system:
  - 1. Specific step-by-step instructions on how to perform and apply all functions, features, modes, etc. mentioned in the controls training sections of this specification and other features of this system. Provide an index and clear table of contents. Include the detailed technical manual for programming

- and customizing control loops and algorithms.
2. Full as-built set of control drawings.
3. Full as-built sequence of operations for each piece of equipment.
4. Full points list; in addition to the information on the original points list submittal, include a listing of all rooms with the following information for each room:
  - a. Floor.
  - b. Room number.
  - c. Room name.
  - d. Air handler unit ID.
  - e. Reference drawing number.
  - f. Air terminal unit tag ID.
  - g. Heating and/or cooling valve tag ID.
  - h. Minimum air flow rate.
  - i. Maximum air flow rate.
5. Full print out of all schedules and set points after testing and acceptance of the system.
6. Full as-built print out of software program.
7. Electronic copy on disk of the entire program for this facility.
8. Marking of all system sensors and thermostats on the as-built floor plan and HVAC drawings with their control system designations.
9. Maintenance instructions, including sensor calibration requirements and methods by sensor type, etc.
10. Control equipment component submittals, parts lists, etc.
11. Warranty requirements.
12. Copies of all checkout tests and calibrations performed by the Contractor (not commissioning tests).
13. Organize and subdivide the manual with permanently labeled tabs for each of the following data in the given order:
  - a. Sequences of operation.
  - b. Control drawings.
  - c. Points lists.
  - d. Controller and/or module data.
  - e. Thermostats and timers.
  - f. Sensors and DP switches.
  - g. Valves and valve actuators.
  - h. Dampers and damper actuators.
  - i. Program setups (software program printouts).
- E Project Record Documents: See Section 01 78 00 for additional requirements.
  1. Submit updated version of control system documentation, for inclusion with operation and maintenance data.
  2. Show actual locations of all static and differential pressure sensors (air, water and building pressure) and air-flow stations on project record drawings.
- F Draft Training Plan: In addition to requirements specified in Section 01 79 00, include:
  1. Follow the recommendations of ASHRAE Guideline 1.1.
  2. Control system manufacturer's recommended training.
  3. Demonstration and instruction on function and overrides of any local packaged controls not controlled by the HVAC control system.
- G Training Manuals: See Section 01 79 00 for additional requirements.
  1. Provide three extra copies of the controls training manuals in a separate manual from the O&M manuals.

## **PART 2 PRODUCTS**

### **2.01 TEST EQUIPMENT**

- A Provide all standard testing equipment required to perform startup and initial checkout and required functional performance testing; unless otherwise noted such testing equipment will NOT become the property of Owner.

- B Equipment-Specific Tools: Where special testing equipment, tools and instruments are specific to a piece of equipment, are only available from the vendor, and are required in order to accomplish startup or Functional Testing, provide such equipment, tools, and instruments as part of the work at no extra cost to Owner; such equipment, tools, and instruments are to become the property of Owner.

### **PART 3 EXECUTION**

#### **3.01 PREPARATION**

- A Cooperate with the Commissioning Authority in development of the Prefunctional Checklists and Functional Test Procedures.
- B Furnish additional information requested by the Commissioning Authority.
- C Prepare a preliminary schedule for HVAC pipe and duct system testing, flushing and cleaning, equipment start-up and testing, adjusting, and balancing start and completion for use by the Commissioning Authority; update the schedule as appropriate.
- D Notify the Commissioning Authority when pipe and duct system testing, flushing, cleaning, startup of each piece of equipment and testing, adjusting, and balancing will occur; when commissioning activities not yet performed or not yet scheduled will delay construction notify ahead of time and be proactive in seeing that the Commissioning Authority has the scheduling information needed to efficiently execute the commissioning process.
- E Put all HVAC equipment and systems into operation and continue operation during each working day of testing, adjusting, and balancing and commissioning, as required.
- F Provide test holes in ducts and plenums where directed to allow air measurements and air balancing; close with an approved plug.
- G Provide temperature and pressure taps in accordance with Contract Documents.

#### **3.02 INSPECTING AND TESTING - GENERAL**

- A Submit startup plans, startup reports, and Prefunctional Checklists for each item of equipment or other assembly to be commissioned.
- B Perform the Functional Tests directed by the Commissioning Authority for each item of equipment or other assembly to be commissioned.
- C Provide two-way radios for use during the testing.
- D Valve/Damper Stroke Setup and Check:
  - 1. For all valve/damper actuator positions checked, verify the actual position against the control system readout.
  - 2. Set pump/fan to normal operating mode.
  - 3. Command valve/damper closed; visually verify that valve/damper is closed and adjust output zero signal as required.
  - 4. Command valve/damper open; verify position is full open and adjust output signal as required.
  - 5. Command valve/damper to a few intermediate positions.
  - 6. If actual valve/damper position does not reasonably correspond, replace actuator or add pilot positioner (for pneumatics).
- E Isolation Valve or System Valve Leak Check: For valves not by coils.
  - 1. With full pressure in the system, command valve closed.
  - 2. Use an ultra-sonic flow meter to detect flow or leakage.
- F Deficiencies: Correct deficiencies and re-inspect or re-test, as applicable, at no extra cost to Owner.

#### **3.03 TAB COORDINATION**

- A TAB: Testing, adjusting, and balancing of HVAC.
- B Coordinate commissioning schedule with TAB schedule.
- C Review the TAB plan to determine the capabilities of the control system toward completing TAB.
- D Provide all necessary unique instruments and instruct the TAB technicians in their use; such as handheld control system interface for setting terminal unit boxes, etc.
- E Have all required Prefunctional Checklists, calibrations, startup and component Functional Tests of the system completed and approved by the Commissioning Authority prior to starting TAB.
- F Provide a qualified control system technician to operate the controls to assist the TAB technicians or provide sufficient training for the TAB technicians to operate the system without assistance.

### 3.04 CONTROL SYSTEM FUNCTIONAL TESTING

- A Prefunctional Checklists for control system components will require a signed and dated certification that all system programming is complete as required to accomplish the requirements of Contract Documents and the detailed Sequences of Operation documentation submittal.
- B Do not start Functional Testing until all controlled components have themselves been successfully Functionally Tested in accordance with Contract Documents.
- C Using a skilled technician who is familiar with this building, execute the Functional Testing of the control system as required by the Commissioning Authority.
- D Functional Testing of the control system constitutes demonstration and trend logging of control points monitored by the control system.
  - 1. The scope of trend logging is partially specified; trend log up to 50 percent more points than specified at no extra cost to Owner.
  - 2. Perform all trend logging specified in Prefunctional Checklists and Functional Test procedures.
- E Functionally Test integral or stand-alone controls in conjunction with the Functional Tests of the equipment they are attached to, including any interlocks with other equipment or systems; further testing during control system Functional Test is not required unless specifically indicated below.
- F Demonstrate the following to the Commissioning Authority during testing of controlled equipment; coordinate with commissioning of equipment.
  - 1. Setpoint changing features and functions.
  - 2. Sensor calibrations.
- G Demonstrate to the Commissioning Authority:
  - 1. That all specified functions and features are set up, debugged and fully operable.
  - 2. That scheduling features are fully functional and setup, including holidays.
  - 3. That all graphic screens and value readouts are completed.
  - 4. Correct date and time setting in central computer.
  - 5. That field panels read the same time as the central computer; sample 10 percent of field panels; if any of those fail, sample another 10 percent; if any of those fail test all remaining units at no extra cost to Owner.
  - 6. Functionality of field panels using local operator keypads and local ports (plug-ins) using portable computer/keypad; demonstrate 100 percent of panels and 10 percent of ports; if any ports fail, sample another 10 percent; if any of those fail, test all remaining units at no extra cost to Owner.
  - 7. Power failure and battery backup and power-up restart functions.
  - 8. Global commands features.
  - 9. Security and access codes.
  - 10. Occupant over-rides (manual, telephone, key, keypad, etc.).
  - 11. O&M schedules and alarms.
  - 12. Occupancy sensors and controls.
  - 13. All control strategies and sequences not tested during controlled equipment testing.
- H If the control system, integral control components, or related equipment do not respond to changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice, under any of the conditions, sequences, or modes tested, correct all systems, equipment, components, and software required at no additional cost to Owner.

### 3.05 OPERATION AND MAINTENANCE MANUALS

- A See Section 01 78 00 for additional requirements.
- B Add design intent documentation furnished by Architect to manuals prior to submission to Owner.
- C Submit manuals related to items that were commissioned to Commissioning Authority for review; make changes recommended by Commissioning Authority.
- D Commissioning Authority will add commissioning records to manuals after submission to Owner.

### 3.06 DEMONSTRATION AND TRAINING

- A See Section 01 79 00 for additional requirements.
- B Demonstrate operation and maintenance of HVAC system to Owner' personnel; if during any demonstration, the system fails to perform in accordance with the information included in the O&M manual, stop

demonstration, repair or adjust, and repeat demonstration. Demonstrations may be combined with training sessions if appropriate.

- C These demonstrations are in addition to, and not a substitute for, Prefunctional Checklists and demonstrations to the Commissioning Authority during Functional Testing.
- D Provide classroom and hands-on training of Owner's designated personnel on operation and maintenance of the HVAC system, control system, and all equipment items indicated to be commissioned. Provide the following minimum durations of training:
- E TAB Review: Instruct Owner's personnel for minimum \_\_\_\_ hours, after completion of TAB, on the following:
  - 1. Review final TAB report, explaining the layout and meanings of each data type.
  - 2. Discuss any outstanding deficient items in control, ducting or design that may affect the proper delivery of air or water.
  - 3. Identify and discuss any terminal units, duct runs, diffusers, coils, fans and pumps that are close to or are not meeting their design capacity.
  - 4. Discuss any temporary settings and steps to finalize them for any areas that are not finished.
  - 5. Other salient information that may be useful for facility operations, relative to TAB.
- F HVAC Control System Training: Perform training in at least three phases:
  - 1. Phase 1 - Basic Control System: Provide minimum of 8 hours of actual training on the control system itself. Upon completion of training, each attendee, using appropriate documentation, should be able to perform elementary operations and describe general hardware architecture and functionality of the system.
    - a. This training may be held on-site or at the manufacturer's facility.
    - b. If held off-site, the training may occur prior to final completion of the system installation.
    - c. For off-site training, Contractor shall pay expenses of up to two attendees.
  - 2. Phase 2 - Integrating with HVAC Systems: Provide minimum of 8 hours of on-site, hands-on training after completion of Functional Testing. Include instruction on:
    - a. The specific hardware configuration of installed systems in this facility and specific instruction for operating the installed system, including interfaces with other systems, if any.
    - b. Security levels, alarms, system start-up, shut-down, power outage and restart routines, changing setpoints and alarms and other typical changed parameters, overrides, freeze protection, manual operation of equipment, optional control strategies that can be considered, energy savings strategies and set points that if changed will adversely affect energy consumption, energy accounting, procedures for obtaining vendor assistance, etc.
    - c. Trend logging and monitoring features (values, change of state, totalization, etc.), including setting up, executing, downloading, viewing both tabular and graphically and printing trends; provide practice in setting up trend logging and monitoring during training session.
    - d. Every display screen, allowing time for questions.
    - e. Point database entry and modifications.
  - 3. Phase 3 - Post-Occupancy: Six months after occupancy conduct minimum of 8 hours of training. Tailor training session to questions and topics solicited beforehand from Owner. Also be prepared to address topics brought up and answer questions concerning operation of the system.
- G Provide the services of manufacturer representatives to assist instructors where necessary.
- H Provide the services of the HVAC controls instructor at other training sessions, when requested, to discuss the interaction of the controls system as it relates to the equipment being discussed.

**END OF SECTION 23 08 00**

**SECTION 23 09 13**

**INSTRUMENTATION AND CONTROL DEVICES FOR HVAC**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A Control panels.
- B Control Valves:
  - 1. Ball valves with factory-mounted actuators.
  - 2. Globe valves with factory-mounted actuators.
  - 3. Butterfly valves with factory-mounted actuators.
  - 4. Electronic valve operators.
- C Dampers.
- D Damper Operators:
  - 1. Electric operators.
- E Humidistats:
  - 1. Room humidistats.
  - 2. Limit duct humidistats.
- F Wall-, Surface-, and Duct-Mounted Sensors:
  - 1. Temperature sensors.
  - 2. Humidity sensors.
  - 3. IAQ (indoor air quality) sensors.
  - 4. Airflow meters; pitot tubes.
  - 5. Damper position indicators.
  - 6. Carbon monoxide sensors.
  - 7. Carbon dioxide sensors.
- G Thermostats:
  - 1. Electric thermostats.
  - 2. Freezestats.
  - 3. Room-mount thermostat accessories.
  - 4. Outdoor-reset thermostats.
  - 5. Immersion thermostats.
  - 6. Airstream thermostats.
  - 7. Electric high/low limit duct thermostats.
- H Fan and pump motor run-status monitoring.
- I Pipe-Mounted Sensors and Transmitters:
  - 1. Temperature sensors.
  - 2. Pressure transmitters.
  - 3. Differential pressure transmitters.

**1.02 RELATED REQUIREMENTS**

- A Section 23 05 19 - Meters and Gauges for HVAC Piping: Thermometer sockets and gauge taps.
- B Section 23 21 13 - Hydronic Piping: Installation of control valves, flow switches, temperature sensor sockets, and gauge taps.
- C Section 23 21 14 - Hydronic Specialties.
- D Section 23 33 00 - Air Duct Accessories.
- E Section 25 35 13 - Integrated Automation Actuators and Operators.
- F Section 26 05 83 - Wiring Connections: Electrical characteristics and wiring connections.
- G Section 26 27 26 - Wiring Devices: Elevation of exposed components.

**1.03 REFERENCE STANDARDS**

- A ANSI/FCI 70-2 - Control Valve Seat Leakage; 2021.
- B ASHRAE Std 135 - A Data Communication Protocol for Building Automation and Control Networks; 2020, with Errata and Amendments (2022).
- C NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2020.
- D NEMA DC 3 - Residential Controls - Electrical Wall-Mounted Room Thermostats; 2013.



- E NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2021.
- F ODVA (CIP) - The Common Industrial Protocol (CIP) Standards: EtherNet/IP, DeviceNet, ControlNet, and CompoNet; Current Edition.
- G UL 916 - Energy Management Equipment; Current Edition, Including All Revisions.

#### **1.04 SUBMITTALS**

- A See Section 01 30 00 - 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.

### **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 PANELS**

- A Unitized cabinet type for each system under automatic control with relays and controls mounted in cabinet and temperature indicators, pressure gauges, pilot lights, push buttons and switches flush on cabinet panel face.
- B NEMA 250, general purpose utility enclosures with enameled finished face panel.
- C Provide common keying for all panels.

#### **2.03 CONTROL VALVES**

- A Ball Valves with Factory-Mounted Actuators:
  - 1. Manufacturers:
    - a. Belimo Aircontrols (USA), Inc: [www.belimo.com/#sle](http://www.belimo.com/#sle).
    - b. Johnson Controls International, PLC: [www.johnsoncontrols.com/#sle](http://www.johnsoncontrols.com/#sle).
    - c. Schneider Electric: [www.schneider-electric.us/#sle](http://www.schneider-electric.us/#sle).
  - 2. Service: Use for hot water.
  - 3. Flow Characteristic: Include 2-way, 3-way diverting, and 3-way mixing operation configured to fail normally closed (NC).
  - 4. Replacements in Kind: Provide pressure-independent type.
  - 5. Rangeability: 500 to 1.
  - 6. ANSI Rating: Class 150.
  - 7. Leakage: Class IV (0.1 percent of rated capacity) per ANSI/FCI 70-2.
  - 8. Body Size:
    - a. Under 2-1/2 inches:
      - 1) Connection: NPT.
      - 2) Materials:
        - (a) Body: Brass.
        - (b) Flanges: Ductile iron.
        - (c) Ball: Chrome-plated brass.
        - (d) Stem: Nickel-plated brass.
        - (e) Seat: Graphite-reinforced PTFE with EPDM O-Ring backing.
        - (f) Stem Seal: EPDM O-Rings.
        - (g) Flow Control Disk: Thermoplastic synthetic-resin.
    - b. 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.
  - 9. 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.
- B Globe Valves with Factory-Mounted Actuators:
1. Manufacturers:
    - a. Honeywell International, Inc: [buildingcontrols.honeywell.com/#sle](http://buildingcontrols.honeywell.com/#sle).
    - b. Johnson Controls International, PLC: [www.johnsoncontrols.com/#sle](http://www.johnsoncontrols.com/#sle).
    - c. Schneider Electric: [www.schneider-electric.us/#sle](http://www.schneider-electric.us/#sle).
  2. Up to 2 inches: Bronze body, bronze trim, rising stem, renewable composition disc, screwed ends with backseating capacity repackable under pressure.
  3. Over 2 inches: Iron body, bronze trim, rising stem, plug-type disc, flanged ends, renewable seat and disc.
  4. Hydronic Systems:
    - a. Rate for service pressure of 125 psig at 250 degrees F.
    - b. Replaceable plugs and seats of stainless steel.
    - c. Size for 3 psig maximum pressure drop at design flow rate.
    - d. Provide two-way valves with equal percentage characteristics and three-way valves with linear characteristics. Size two-way valve operators to close valves against pump shut-off head.
- C Electronic Valve Actuators:
1. Manufacturers:
    - a. Honeywell International, Inc: [buildingcontrols.honeywell.com/#sle](http://buildingcontrols.honeywell.com/#sle).
    - b. Johnson Controls International, PLC: [www.johnsoncontrols.com/#sle](http://www.johnsoncontrols.com/#sle).
    - c. Schneider Electric: [www.schneider-electric.us/#sle](http://www.schneider-electric.us/#sle).
  2. Valves shall spring return to normal position as indicated on freeze, fire, or temperature protection.
  3. Select operator for full shut-off at maximum pump differential pressure.

#### 2.04 DAMPERS

- A See Section 23 33 00 for dampers and this section for actuators and operators.

#### 2.05 DAMPER OPERATORS

- A General:
1. Provide actuators with torque capacity sized for minimum of 20 percent greater than maximum design stream velocity and hold tight seal against maximum system pressures.
  2. Provide spring return for two position control and for fail safe operation.
  3. Provide sufficient number of operators to achieve unrestricted movement throughout damper range.
  4. Provide one operator for maximum 36 sq ft damper section.
  5. See Section 25 35 13 for field-mount damper actuators and operators.
- B Electric Operators:
1. Manufacturers:
    - a. Honeywell International, Inc: [buildingcontrols.honeywell.com/#sle](http://buildingcontrols.honeywell.com/#sle).
    - b. Johnson Controls International, PLC: [www.johnsoncontrols.com/#sle](http://www.johnsoncontrols.com/#sle).
    - c. Schneider Electric: [www.schneider-electric.us/#sle](http://www.schneider-electric.us/#sle).
  2. Spring return, adjustable stroke motor having oil immersed gear train, with auxiliary end switch.

#### 2.06 HUMIDISTATS

- A Room Humidistats:
1. Manufacturers:
    - a. Honeywell International, Inc: [buildingcontrols.honeywell.com/#sle](http://buildingcontrols.honeywell.com/#sle).
    - b. Johnson Controls International, PLC: [www.johnsoncontrols.com/#sle](http://www.johnsoncontrols.com/#sle).
    - c. Siemens Industry, Inc: [www.siemens.com/#sle](http://www.siemens.com/#sle).
    - d. Veris Industries: [www.veris.com/#sle](http://www.veris.com/#sle).
    - e. Schneider Electric.
  2. Wall mounted, proportioning type.
  3. Throttling Range: Adjustable 2 percent relative humidity.
  4. Operating Range: 30 to 80 percent.

5. Maximum Temperature: \_\_\_\_ degrees F.

B Limit Duct Humidistats:

1. Manufacturers:

- a. Honeywell International, Inc: [buildingcontrols.honeywell.com/#sle](http://buildingcontrols.honeywell.com/#sle).
- b. Johnson Controls International, PLC: [www.johnsoncontrols.com/#sle](http://www.johnsoncontrols.com/#sle).
- c. Siemens Industry, Inc: [www.siemens.com/#sle](http://www.siemens.com/#sle).
- d. Veris Industries: [www.veris.com/#sle](http://www.veris.com/#sle).

2. Insertion, two-position type.

3. Throttling Range: Adjustable 2 percent relative humidity.

4. Operating Range: 20 to 80 percent.

5. Maximum Temperature: 150 degrees F.

**2.07 WALL-, SURFACE-, AND DUCT-MOUNT SENSORS**

A Temperature Sensors:

1. Manufacturers:

- a. Dwyer Instruments Inc: [www.dwyer-inst.com/#sle](http://www.dwyer-inst.com/#sle).
- b. Johnson Controls International, PLC: [www.johnsoncontrols.com/#sle](http://www.johnsoncontrols.com/#sle).
- c. Veris Industries: [www.veris.com/#sle](http://www.veris.com/#sle).
- d. Schneider Electric.

2. Use thermistor or RTD type temperature sensing elements with characteristics resistant to moisture, vibration, and other conditions consistent with the application without affecting accuracy and life expectancy.

3. Construct RTD of nickel or platinum with base resistance of 1000 ohms at 70 degrees F.

4. 100 ohm platinum RTD is acceptable if used with project DDC controllers.

5. Temperature Sensing Device: Compatible with project DDC controllers.

6. Performance Characteristics:

a. RTD:

- 1) Room Sensor Accuracy: Plus/minus 0.50 degrees F minimum.
- 2) Duct Averaging Accuracy: Plus/minus 0.50 degrees F minimum.
- 3) All Other Accuracy: Plus/minus 0.75 degrees F minimum.
- 4) Range: Minus 40 degrees F through 220 degrees F minimum.

b. Temperature Transmitter:

- 1) Accuracy: 0.10 degree F minimum or plus/minus 0.20 percent of span.
- 2) Output: 4 to 20 mA.

c. Sensing Range:

- 1) Provide limited range sensors if required to sense the range expected for a respective point.
- 2) Use RTD type sensors for extended ranges beyond minus 30 to 230 degrees F.
- 3) Use temperature transmitters in conjunction with RTDs when RTDs are incompatible with DDC controller direct temperature input.

d. Outside Air Sensors: Watertight inlet fitting shielded from direct rays of the sun.

e. Immersion Temperature Sensors: A sensor encased in a corrosion-resistant probe with an indoor junction box service entry body.

f. Room Temperature Sensors with Integral Digital Display:

- 1) Construct for surface or wall box.
- 2) Provide a four button keypad with the following capabilities:
  - (a) Indication of space and outdoor temperatures.
  - (b) Setpoint adjustment to accommodate room setpoint, DDC Input/Output Points List, and Sequence of Operation.
  - (c) Display and control fan operation status.
  - (d) Manual occupancy override and indication of occupancy status.
  - (e) Controller mode status.
  - (f) Password enabled setpoint and override modes.

g. Temperature Averaging Elements:

- 1) Use on duct sensors for ductwork 10 sq ft or larger.
  - 2) Use averaging elements where prone to stratification with sensor length 8 ft or 16 ft.
  - 3) Provide for all mixed air and heating coil discharge sensors regardless of duct size.
  - h. Insertion Elements:
    - 1) Use in ducts not affected by temperature stratification or smaller than 11 sq inches.
- B Humidity Sensors, Duct-Mounted:**
1. Manufacturers:
    - a. Dwyer Instruments Inc: [www.dwyer-inst.com/#sle](http://www.dwyer-inst.com/#sle).
    - b. Johnson Controls International, PLC: [www.johnsoncontrols.com/#sle](http://www.johnsoncontrols.com/#sle).
    - c. Veris Industries; HD Series: [www.veris.com/#sle](http://www.veris.com/#sle).
    - d. Schneider Electric.
  2. Digitally profiled thin-film capacitive sensor probe extended from die-cast metal, weather-proof plastic or metal housing designed for duct mounting.
  3. Measuring Scale: 0 to 100 percent RH, noncondensing, temperature compensated.
  4. Hardwired Output: Two-wire, 4 to 20 mA, loop powered.
  5. Accuracy: Plus/minus 1 percent between 20 to 40 percent RH linear range, NIST traceable with multi-point calibration.
- C IAQ (Indoor Air Quality) Sensors:**
1. Manufacturers:
    - a. Automated Logic, a company of Carrier Global Corporation: [www.automatedlogic.com/#sle](http://www.automatedlogic.com/#sle).
    - b. Honeywell International, Inc: [buildingcontrols.honeywell.com/#sle](http://buildingcontrols.honeywell.com/#sle).
    - c. Veris Industries; CW2 Series: [www.veris.com/#sle](http://www.veris.com/#sle).
  2. Form Factor: Surface mounted, desk mounted, or single-gang electrical-box-mounted module made of high-impact plastic or other resilient material.
  3. Temperature Sensor:
    - a. Solid-state, integrated circuit type, 32 to 122 deg F range.
    - b. Accuracy: Plus/minus two percent within 0.1 deg resolution.
  4. CO<sub>2</sub> (Carbon Dioxide) Monitoring Sensor:
    - a. Non-dispersive infrared (NDIR) type, 0 to 100 %RH range.
    - b. Accuracy: Plus/minus 30 ppm within three percent of measured value.
  5. Humidity Monitoring Sensor:
    - a. Thin-film capacitive, replaceable type, 0 to 2,000 or 5,000 ppm range, noncondensing.
    - b. Accuracy: Plus/minus two percent within 1.5 percent of measured value.
  6. BAS, SCADA, or other Integrated Automation Link: ASHRAE Std 135 BACnet MS/TP.
- D Carbon Dioxide Sensors, Duct and Wall:**
1. Manufacturers:
    - a. Greystone Energy Systems, Inc; DES-100: [www.greystoneenergy.com/#sle](http://www.greystoneenergy.com/#sle).
    - b. Macurco, a brand of Aerionics, Inc: [www.macurco.com/#sle](http://www.macurco.com/#sle).
    - c. Veris Industries: [www.veris.com/#sle](http://www.veris.com/#sle).
  2. General: Provide nondispersive infrared (NDIR), diffusion sampling CO<sub>2</sub> sensors with integral transducers and linear output.
  3. Air Temperature: Range of 32 to 122 degrees F.
  4. Relative Humidity: Range of 0 to 95 percent (noncondensing).
  5. Calibration Characteristics:
    - a. Automatically compensating algorithm for sensor drift due to sensor degradation.
    - b. Maximum Drift: 2 percent.
    - c. User calibratable with a minimum calibration interval of 5 years.
  6. Construction:
    - a. Sensor Chamber: Noncorrosive material for neutral effect on carbon dioxide sample.
    - b. Provide duct mounted sensors with duct probe designed to protect sensing element from dust accumulation and mechanical damage.
    - c. Housing: High impact plastic.

## 2.08 THERMOSTATS

- A Electric Thermostats:
  - 1. Manufacturers:
    - a. Honeywell International, Inc: [buildingcontrols.honeywell.com/#sle](http://buildingcontrols.honeywell.com/#sle).
    - b. Johnson Controls International, PLC: [www.johnsoncontrols.com/#sle](http://www.johnsoncontrols.com/#sle).
    - c. Siemens Industry, Inc: [www.siemens.com/#sle](http://www.siemens.com/#sle).
    - d. Schneider Electric.
  - 2. Type: NEMA DC 3, 24 volts, with setback/setup temperature control.
  - 3. Service: Cooling and heating.
  - 4. Covers: Locking with set point adjustment, with thermometer.
- B Freezestats:
  - 1. Manufacturers:
    - a. Honeywell International, Inc: [buildingcontrols.honeywell.com/#sle](http://buildingcontrols.honeywell.com/#sle).
    - b. Johnson Controls International, PLC: [www.johnsoncontrols.com/#sle](http://www.johnsoncontrols.com/#sle).
    - c. Siemens Industry, Inc: [www.siemens.com/#sle](http://www.siemens.com/#sle).
    - d. Veris Industries; TZ Series: [www.veris.com/#sle](http://www.veris.com/#sle).
    - e. Schneider Electric.
  - 2. Configuration: Vapor-filled capillary.
  - 3. Probe Sensing Length: 20 feet.
  - 4. Setpoint Adjust Control: Screw with manual reset switch.
  - 5. Switch Type: SPDT, snap-action, form C in dust-protected enclosure.
  - 6. Mounting: Locate on cooling coil intake side.
  - 7. Field Interface: Connect load line-voltage to starter.
  - 8. Electrical Rating: As indicated on drawings.
- C Room-Mounted Thermostat Accessories:
  - 1. Thermostat Covers: Brushed aluminum.
  - 2. Insulating Bases: For thermostats located on exterior walls.
- D Outdoor Reset Thermostats:
  - 1. Remote bulb or bimetal rod and tube type, proportioning action with adjustable throttling range, adjustable setpoint.
  - 2. Scale range: Minus 10 to 70 degrees F.
- E Immersion Thermostats:
  - 1. Remote bulb or bimetallic rod and tube type, proportional action with adjustable setpoint and adjustable throttling range.
- F Airstream Thermostats:
  - 1. Remote bulb or bimetallic rod and tube type, proportional action with adjustable setpoint in middle of range and adjustable throttling range.
  - 2. Averaging service remote bulb element: 7.5 feet.
- G Electric High/Low Limit Duct Thermostats:
  - 1. Manufacturers:
    - a. Honeywell International, Inc: [buildingcontrols.honeywell.com/#sle](http://buildingcontrols.honeywell.com/#sle).
    - b. Johnson Controls International, PLC: [www.johnsoncontrols.com/#sle](http://www.johnsoncontrols.com/#sle).
    - c. Siemens Industry, Inc: [www.siemens.com/#sle](http://www.siemens.com/#sle).
    - d. Schneider Electric.
    - e. Substitutions: See Section 01 60 00 - Product Requirements.
  - 2. Snap acting, single pole, single throw, manual reset switch that trips if temperature sensed across any 12 inches of bulb length is above, equal to, or below setpoint,
  - 3. Bulb length: Minimum 20 feet.
  - 4. Provide one thermostat for every 20 sq ft of coil surface.

## 2.09 FAN AND PUMP MOTOR RUN-STATUS MONITORING

- A Current Switches:
  - 1. Manufacturers:

- a. Automation Components, Inc: [www.workaci.com/#sle](http://www.workaci.com/#sle).
- b. Functional Devices, Inc: [www.functionaldevices.com/#sle](http://www.functionaldevices.com/#sle).
- c. Schneider Electric: [www.schneider-electric.us/#sle](http://www.schneider-electric.us/#sle).
2. Mini Solid-Core: 2-State, On/Off digital output of motor status with adjustable trip point to detect belt loss or mechanical failure.
3. Maximum AC Current Monitoring Value: As indicated on drawings.

## 2.10 PIPE-MOUNTED SENSORS AND TRANSMITTERS

- A Temperature Sensors:
1. Manufacturers:
    - a. Johnson Controls International, PLC: [www.johnsoncontrols.com/#sle](http://www.johnsoncontrols.com/#sle).
    - b. Siemens Industry, Inc: [www.siemens.com/#sle](http://www.siemens.com/#sle).
    - c. Veris Industries: [www.veris.com/#sle](http://www.veris.com/#sle).
    - d. Schneider Electric.
    - e. Substitutions: See Section 01 60 00 - Product Requirements.
  2. Pipe-mounted temperature probe tied to weather-resistant enclosure for direct insertion into compatible liquids or gases or inserted into intermediary thermal grease-filled pipe-well compatible with interfaced fluid.
  3. Sensor Type: 1,000 ohm Platinum RTD.
  4. Transmitter: Fitted within probe-interface enclosure, calibrated.
    - a. Monitoring Range: 32 to 122 degrees F, adjustable.
    - b. Hardwired Output: Two-wire, 4 to 20 mA, loop powered.
    - c. Accuracy: Plus/minus three percent. adjustable on the transmitter end.
  5. Accessories: Provide downstream PT test plug and brass pipe-well.

## 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.
- D Sequence work to ensure installation of components is complementary to installation of similar components in other systems.
- E Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.
- F Ensure installation of components is complementary to installation of similar components.
- G Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.

### 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 27 26.
- C Mount outdoor reset thermostats and outdoor sensors indoors, with sensing elements outdoors with sun shield.
- D Provide guards on thermostats in Gymnasium..
- E Install damper motors on outside of duct in warm areas. Do not install motors in locations at outdoor temperatures.
- F Mount control panels adjacent to associated equipment on vibration free walls or free-standing angle iron supports. One cabinet may accommodate more than one system in same equipment room. Provide engraved plastic nameplates for instruments and controls inside cabinet and engraved plastic nameplates on cabinet face.
- G Install "hand/off/auto" selector switches to override automatic interlock controls when switch is in "hand" position.

- H Provide conduit and electrical wiring in accordance with Section 26 05 83. Electrical material and installation shall be in accordance with appropriate requirements of Division 26.

**END OF SECTION 23 09 13**

**SECTION 23 09 23**  
**DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A System description.
- B Operator interface.
- C Controllers.
- D Power supplies and line filtering.
- E System software.
- F Controller software.
- G HVAC control programs.

**1.02 RELATED REQUIREMENTS**

- A Section 23 09 13 - Instrumentation and Control Devices for HVAC.
- B Section 26 05 83 - Wiring Connections: Electrical characteristics and wiring connections.

**1.03 REFERENCE STANDARDS**

- A ASHRAE Std 135 - A Data Communication Protocol for Building Automation and Control Networks; 2020, with Errata and Amendments (2022).
- B CTA-709.1 - Control Network Protocol Specification; 2019.
- C MIL-STD-810 - Environmental Engineering Considerations and Laboratory Tests; 2019h.
- D NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

**1.04 SUBMITTALS**

- A See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B Shop Drawings:
  - 1. Indicate trunk cable schematic showing programmable control unit locations, and trunk data conductors.
  - 2. Indicate system graphics indicating monitored systems, data (connected and calculated) point addresses, and operator notations. Provide demonstration digital media containing graphics.
  - 3. Show system configuration with peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.
  - 4. Indicate description and sequence of operation of operating, user, and application software.
- C Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors.
  - 1. Revise shop drawings to reflect actual installation and operating sequences.
  - 2. Include submittals data in final "Record Documents" form.
- D Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner s name and registered with manufacturer.

**1.05 WARRANTY**

- A See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
- B Provide five year manufacturer's warranty for field programmable micro-processor based units.

**PART 2 PRODUCTS**

**2.01 MANUFACTURERS**

- A Johnson Controls, Inc; \_\_\_\_\_: [www.johnsoncontrols.com/#sle](http://www.johnsoncontrols.com/#sle).
- B Schneider Electric: [www.schneider-electric.us/#sle](http://www.schneider-electric.us/#sle).
- C Siemens AG, Building Technologies Division; \_\_\_\_\_: [www.siemens.com/#sle](http://www.siemens.com/#sle).

**2.02 SYSTEM DESCRIPTION**

- A Automatic temperature control field monitoring and control system using field programmable micro-processor based units.
- B Base system on distributed system of fully intelligent, stand-alone controllers, operating in a multi-tasking, multi-user environment on token passing network, with central and remote hardware, software, and interconnecting wire and conduit.



- C Include computer software and hardware, operator input/output devices, control units, local area networks (LAN), sensors, control devices, actuators.
- D Controls for variable air volume terminals, radiation, reheat coils, unit heaters, fan coils, and the like when directly connected to the control units. Individual terminal unit control is specified in Section 23 09 13.
- E Provide control systems consisting of thermostats, control valves, dampers and operators, indicating devices, interface equipment and other apparatus and accessories required to operate mechanical systems, and to perform functions specified.
- F Include installation and calibration, supervision, adjustments, and fine tuning necessary for complete and fully operational system.

### **2.03 OPERATOR INTERFACE**

- A PC Based Work Station:
- B Workstation, controllers, and control backbone to communicate using BACnet protocol and addressing.
- C Hardware:
  - 1. Desktop:
    - a. Computer(s) and display(s) to be provided by DDC controls manufacturer.
    - b. Quantity: Provide allowance for 1 computer(s).
    - c. Minimum RAM: 32 GB.
    - d. Minimum Processing Speed: 16 CORE.
    - e. Minimum Hard Drive Memory: 512 GB.
    - f. Drives: 2.
    - g. Ports: 4.
    - h. Monitor: 19".
    - i. Location(s): As indicated on the drawings.
    - j. Network Connection:
      - 1) Ethernet interface card.
      - 2) Minimum Speed: \_\_\_\_\_.
    - k. System Printer:
      - 1) Printer(s) to be provided by DDC controls manufacturer.
      - 2) Quantity: Provide allowance for 1 computers.
      - 3) Locations(s): As indicated on the drawings.

### **2.04 CONTROLLERS**

- A Building Controllers:
  - 1. General:
    - a. Manage global strategies by one or more, independent, standalone, microprocessor based controllers.
    - b. Provide sufficient memory to support controller's operating system, database, and programming requirements.
    - c. Share data between networked controllers.
    - d. Controller operating system manages input and output communication signals allowing distributed controllers to share real and virtual object information and allowing for central monitoring and alarms.
    - e. Utilize real-time clock for scheduling.
    - f. Continuously check processor status and memory circuits for abnormal operation.
    - g. Controller to assume predetermined failure mode and generate alarm notification upon detection of abnormal operation.
    - h. Communication with other network devices to be based on assigned protocol.
  - 2. Communication:
    - a. Controller to reside on a BACnet network using ISO 8802-3 (ETHERNET) Data Link/Physical layer protocol.
    - b. Perform routing when connected to a network of custom application and application specific controllers.

- c. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.
  3. Anticipated Environmental Ambient Conditions:
    - a. Outdoors and/or in Wet Ambient Conditions:
      - 1) Mount within waterproof enclosures.
      - 2) Rated for operation at 40 to 150 degrees F.
    - b. Conditioned Space:
      - 1) Mount within dustproof enclosures.
      - 2) Rated for operation at 32 to 120 degrees F.
  4. Provisions for Serviceability:
    - a. Diagnostic LEDs for power, communication, and processor.
    - b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.
  5. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.
  6. Power and Noise Immunity:
    - a. Maintain operation at 90 to 110 percent of nominal voltage rating.
    - b. Perform orderly shutdown below 80 percent of nominal voltage.
    - c. Operation protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W. at 3 feet.
- B Application Specific Controllers:
  1. General:
    - a. Not fully user programmable, microprocessor based controllers dedicated to control specific equipment.
    - b. Customized for operation within the confines of equipment served.
    - c. Communication with other network devices to be based on assigned protocol.
  2. Communication:
    - a. Controller to reside on a BACnet network using MS/TP Data Link/Physical layer protocol.
    - b. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.
  3. Anticipated Environmental Ambient Conditions:
    - a. Outdoors and/or in Wet Ambient Conditions:
      - 1) Mount within waterproof enclosures.
      - 2) Rated for operation at 40 to 150 degrees F.
    - b. Conditioned Space:
      - 1) Mount within dustproof enclosures.
      - 2) Rated for operation at 32 to 120 degrees F.
  4. Provisions for Serviceability:
    - a. Diagnostic LEDs for power, communication, and processor.
    - b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.
  5. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.
  6. Power and Noise Immunity:
    - a. Maintain operation at 90 to 110 percent of nominal voltage rating.
    - b. Perform orderly shutdown below 80 percent of nominal voltage.
    - c. Operation protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 3 feet.
- C Input/Output Interface:
  1. Hardwired inputs and outputs tie into the DDC system through building, custom application, or application specific controllers.
  2. All Input/Output Points:

- a. Protect controller from damage resulting from any point short-circuiting or grounding and from voltage up to 24 volts of any duration.
- b. Provide universal type for building and custom application controllers where input or output is software designated as either binary or analog type with appropriate properties.
3. Binary Inputs:
  - a. Allow monitoring of On/Off signals from remote devices.
  - b. Provide wetting current of 12 mA minimum, compatible with commonly available control devices and protected against the effects of contact bounce and noise.
  - c. Sense dry contact closure with power provided only by the controller.
4. Analog Inputs:
  - a. Allow for monitoring of low voltage 0 to 10 VDC, 4 to 20 mA current, or resistance signals (thermistor, RTD).
  - b. Compatible with and field configurable to commonly available sensing devices.
5. Binary Outputs:
  - a. Used for On/Off operation or a pulsed low-voltage signal for pulse width modulation control.
  - b. Outputs provided with three position (On/Off/Auto) override switches.
  - c. Status lights for building and custom application controllers to be selectable for normally open or normally closed operation.
6. Analog Outputs:
  - a. Monitoring signal provides a 0 to 10 VDC or a 4 to 20 mA output signal for end device control.
  - b. Provide status lights and two position (AUTO/MANUAL) switch for building and custom application controllers with manually adjustable potentiometer for manual override on building and custom application controllers.
  - c. Drift to not exceed 0.4 percent of range per year.
7. Tri State Outputs:
  - a. Coordinate two binary outputs to control three point, floating type, electronic actuators without feedback.
  - b. Limit the use of three point, floating devices to the following zone and terminal unit control applications:
  - c. Control algorithms run the zone actuator to one end of its stroke once every 24 hours for verification of operator tracking.
8. System Object Capacity:
  - a. System size to be expandable to twice the number of input output objects required by providing additional controllers, including associated devices and wiring.
  - b. Hardware additions or software revisions for the installed operator interfaces are not to be required for future, system expansions.

## 2.05 POWER SUPPLIES AND LINE FILTERING

### A Power Supplies:

1. Provide UL listed control transformers with Class 2 current limiting type or over-current protection in both primary and secondary circuits for Class 2 service as required by the NEC.
2. Limit connected loads to 80 percent of rated capacity.
3. Match DC power supply to current output and voltage requirements.
4. Unit to be full wave rectifier type with output ripple of 5.0 mV maximum peak to peak.
5. Regulation to be 1 percent combined line and load with 100 microsecond response time for 50 percent load changes.
6. Provide over-voltage and over-current protection to withstand a 150 percent current overload for 3 seconds minimum without trip-out or failure.
7. Operational Ambient Conditions: 32 to 120 degrees F.
8. EM/RF meets FCC Class B and VDE 0871 for Class B and MIL-STD-810 for shock and vibration.
9. Line voltage units UL recognized and CSA approved.

### B Power Line Filtering:

1. Provide external or internal transient voltage and surge suppression component for all workstations and controllers.
2. Minimum surge protection attributes:
  - a. Dielectric strength of 1000 volts minimum.
  - b. Response time of 10 nanoseconds or less.
  - c. Transverse mode noise attenuation of 65 dB or greater.
  - d. Common mode noise attenuation of 150 dB or greater at 40 to 100 Hz.

## 2.06 SYSTEM SOFTWARE

### A Operating System:

1. Concurrent, multi-tasking capability.
  - a. Common Software Applications Supported: Microsoft Excel.
2. System Graphics:
  - a. Allow up to 10 graphic screens, simultaneously displayed for comparison and monitoring of system status.
  - b. Animation displayed by shifting image files based on object status.
  - c. Provide method for operator with password to perform the following:
    - 1) Move between, change size, and change location of graphic displays.
    - 2) Modify on-line.
    - 3) Add, delete, or change dynamic objects consisting of:
      - (a) Analog and binary values.
      - (b) Dynamic text.
      - (c) Static text.
      - (d) Animation files.
3. Custom Graphics Generation Package:
  - a. Create, modify, and save graphic files and visio format graphics in PCX formats.
  - b. HTML graphics to support web browser compatible formats.
  - c. Capture or convert graphics from AutoCAD.
4. Standard HVAC Graphics Library:
  - a. HVAC Equipment:
    - 1) Air Handlers.
  - b. Ancillary Equipment:
    - 1) Fans.
    - 2) Coils.
    - 3) Dampers.

### B Workstation System Applications:

1. Automatic System Database Save and Restore Functions:
  - a. Current database copy of each Building Controller is automatically stored on hard disk.
  - b. Automatic update occurs upon change in any system panel.
  - c. In the event of database loss in any system panel, the first workstation to detect the loss automatically restores the database for that panel unless disabled by the operator.
2. Manual System Database Save and Restore Functions by Operator with Password Clearance:
  - a. Save database from any system panel.
  - b. Clear a panel database.
  - c. Initiate a download of a specified database to any system panel.
3. Software provided allows system configuration and future changes or additions by operators under proper password protection.
4. On-line Help:
  - a. Context-sensitive system assists operator in operation and editing.
  - b. Available for all applications.
  - c. Relevant screen data provided for particular screen display.
  - d. Additional help available via hypertext.
5. Security:

- a. Operator log-on requires user name and password to view, edit, add, or delete data.
- b. System security selectable for each operator.
- c. System supervisor sets passwords and security levels for all other operators.
- d. Operator passwords to restrict functions accessible to viewing and/or changing system applications, editor, and object.
- e. Automatic, operator log-off results from keyboard or mouse inactivity during user-adjustable, time period.
- f. All system security data stored in encrypted format.
6. System Diagnostics:
  - a. Operations Automatically Monitored:
    - 1) Workstations.
    - 2) Printers.
    - 3) Modems.
    - 4) Network connections.
    - 5) Building management panels.
    - 6) Controllers.
  - b. Device failure is annunciated to the operator.
7. Alarm Processing:
  - a. All system objects are configurable to "alarm in" and "alarm out" of normal state.
  - b. Configurable Objects:
    - 1) Alarm limits.
    - 2) Alarm limit differentials.
    - 3) States.
    - 4) Reactions for each object.
8. Alarm Messages:
  - a. Descriptor: English language.
  - b. Recognizable Features:
    - 1) Source.
    - 2) Location.
    - 3) Nature.
9. Configurable Alarm Reactions by Workstation and Time of Day:
  - a. Logging.
  - b. Printing.
  - c. Starting programs.
  - d. Displaying messages.
  - e. Dialing out to remote locations.
  - f. Paging.
  - g. Providing audible annunciation.
  - h. Displaying specific system graphics.
10. Custom Trend Logs:
  - a. Definable for any data object in the system including interval, start time, and stop time.
  - b. Trend Data:
    - 1) Sampled and stored on the building controller panel.
    - 2) Archivable on hard disk.
    - 3) Retrievable for use in reports, spreadsheets and standard database programs.
    - 4) Archival on LAN accessible storage media including hard disk, tape, Raid array drive, and virtual cloud environment.
    - 5) Protected and encrypted format to prevent manipulation, or editing of historical data and event logs.
11. Alarm and Event Log:
  - a. View all system alarms and change of states from any system location.
  - b. Events listed chronologically.

- c. Operator with proper security acknowledges and clears alarms.
- d. Alarms not cleared by operator are archived to the workstation hard disk.
- 12. Object, Property Status and Control:
  - a. Provide a method to view, edit if applicable, the status of any object and property in the system.
  - b. Status Available by the Following Methods:
    - 1) Menu.
    - 2) Graphics.
    - 3) Custom Programs.
- 13. Reports and Logs:
  - a. Reporting Package:
    - 1) Allows operator to select, modify, or create reports.
    - 2) Definable as to data content, format, interval, and date.
    - 3) Archivable to hard disk.
  - b. Real-time logs available by type or status such as alarm, lockout, normal, etc.
  - c. Stored on hard disk and readily accessible by standard software applications, including spreadsheets and word processing.
  - d. Set to be printed on operator command or specific time(s).
- 14. Reports:
  - a. Standard:
    - 1) Objects with current values.
    - 2) Current alarms not locked out.
    - 3) Disabled and overridden objects, points and SNVTs.
    - 4) Objects in manual or automatic alarm lockout.
    - 5) Objects in alarm lockout currently in alarm.
    - 6) Logs:
      - (a) Alarm History.
      - (b) System messages.
      - (c) System events.
      - (d) Trends.
  - b. Custom:
    - 1) Daily.
    - 2) Weekly.
    - 3) Monthly.
    - 4) Annual.
    - 5) Time and date stamped.
    - 6) Title.
    - 7) Facility name.
  - c. Tenant Override:
    - 1) Monthly report showing total, requested, after-hours HVAC and lighting services on a daily basis for each tenant.
    - 2) Annual report showing override usage on a monthly basis.
- C Workstation Applications Editors:
  - 1. Provide editing software for each system application at PC workstation.
  - 2. Downloaded application is executed at controller panel.
  - 3. Full screen editor for each application allows operator to view and change:
    - a. Configuration.
    - b. Name.
    - c. Control parameters.
    - d. Set-points.
  - 4. Scheduling:
    - a. Monthly calendar indicates schedules, holidays, and exceptions.
    - b. Allows several related objects to be scheduled and copied to other objects or dates.

- c. Start and stop times adjustable from master schedule.
- 5. Custom Application Programming:
  - a. Create, modify, debug, edit, compile, and download custom application programming during operation and without disruption of all other system applications.
  - b. Programming Features:
    - 1) English oriented language, based on BASIC, FORTRAN, C, or PASCAL syntax allowing for free form programming.
    - 2) Alternative language graphically based using appropriate function blocks suitable for all required functions and amenable to customizing or compounding.
    - 3) Insert, add, modify, and delete custom programming code that incorporates word processing features such as cut/paste and find/replace.
    - 4) Allows the development of independently, executing, program modules designed to enable and disable other modules.
    - 5) Debugging/simulation capability that displays intermediate values and/or results including syntax/execution error messages.
    - 6) Support for conditional statements (IF/THEN/ELSE/ELSE-F) using compound Boolean (AND, OR, and NOT) and/or relations (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.
    - 7) Support for floating-point arithmetic utilizing plus, minus, divide, times, square root operators; including absolute value; minimum/maximum value from a list of values for mathematical functions.
    - 8) Language consisting of resettable, predefined, variables representing time of day, day of the week, month of the year, date; and elapsed time in seconds, minutes, hours, and days where the variable values can be used in IF/THEN comparisons, calculations, programming statement logic, etc.
    - 9) Language having predefined variables representing status and results of the system software enables, disables, and changes the set points of the controller software.

### **PART 3 EXECUTION**

#### **3.01 EXAMINATION**

- A Verify existing conditions before starting work.
- B Verify that conditioned power supply is available to the control units and to the operator work station.  
Verify that field end devices, wiring, and pneumatic tubing is installed prior to installation proceeding.

#### **3.02 INSTALLATION**

- A Install control units and other hardware in position on permanent walls where not subject to excessive vibration.
- B Install software in control units and in operator work station. Implement all features of programs to specified requirements and appropriate to sequence of operation. Refer to Section 23 09 93.
- C Provide conduit and electrical wiring in accordance with Section 26 05 83. Electrical material and installation shall be in accordance with appropriate requirements of Division 26.

#### **3.03 MANUFACTURER'S FIELD SERVICES**

- A Start and commission systems. Allow sufficient time for start-up and commissioning prior to placing control systems in permanent operation.
- B Provide service engineer to instruct Owner's representative in operation of systems plant and equipment for 3 day period.
- C Provide basic operator training for 4 persons on data display, alarm and status descriptors, requesting data, execution of commands and request of logs. Include a minimum of 40 hours dedicated instructor time.  
Provide training on site.

#### **3.04 DEMONSTRATION AND INSTRUCTIONS**

- A Demonstrate complete and operating system to Owner.

#### **3.05 MAINTENANCE**

- A See Section 01 70 00 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.

- B Provide service and maintenance of energy management and control systems for one years from Date of Substantial Completion.
- C Provide two complete inspections, one in each season, to inspect, calibrate, and adjust controls as required, and submit written reports.
- D Provide complete service of systems, including call backs. Make minimum of \_\_\_\_ complete normal inspections of approximately \_\_\_\_ hours duration in addition to normal service calls to inspect, calibrate, and adjust controls, and submit written reports.

**END OF SECTION 23 09 23**



**SECTION 23 21 13**  
**HYDRONIC PIPING**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A Hydronic system requirements.
- B Heating water piping, above grade.
- C Heating water and glycol piping, above grade.
- D Pipe hangers and supports.
- E Unions, flanges, mechanical couplings, and dielectric connections.
- F Valves:
  - 1. Ball valves.
  - 2. Check valves.
  - 3. Pressure independent temperature control valves and balancing valves.

**1.02 REFERENCE STANDARDS**

- A ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators; 2023.
- B ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; 2021.
- C ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard; 2020.
- D ASME B16.15 - Cast Copper Alloy Threaded Fittings: Classes 125 and 250; 2018.
- E ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2021.
- F ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2021.
- G ASME B16.34 - Valves — Flanged, Threaded, and Welding End; 2020.
- H ASME B31.9 - Building Services Piping; 2020.
- I ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2022.
- J ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2023.
- K ASTM A536 - Standard Specification for Ductile Iron Castings; 1984, with Editorial Revision (2019).
- L ASTM B32 - Standard Specification for Solder Metal; 2020.
- M ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2022.
- N ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2020.
- O AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding; 2019.
- P AWS D1.1/D1.1M - Structural Welding Code - Steel; 2020, with Errata (2022).
- Q MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2018, with Amendment (2019).

**1.03 ADMINISTRATIVE REQUIREMENTS**

- A Coordination: Coordinate the installation of \_\_\_\_\_ with size, location and installation of service utilities.

**1.04 SUBMITTALS**

- A See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B Welders Certificate: Include welders certification of compliance with ASME BPVC-IX.
- C Product Data:
  - 1. Include data on pipe materials, pipe fittings, valves, and accessories.
  - 2. Provide manufacturers catalog information.

**1.05 QUALITY ASSURANCE**

- A Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section, with minimum three years of documented experience.
- B Installer Qualifications: Company specializing in performing work of the type specified in this section, with minimum 5 years of experience.
- C Provide all grooved joint couplings, fittings, valves, specialties, and grooving tools from a single manufacturer.

- D Date stamp all castings used for coupling housings, fittings, valve bodies, etc. for quality assurance and traceability.
- E Welder Qualifications: Certify in accordance with ASME BPVC-IX.
  - 1. Provide certificate of compliance from authority having jurisdiction, indicating approval of welders.

#### 1.06 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 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. 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:

#### 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 D1.1/D1.1M welded.
  - 2. Threaded Joints: ASME B16.3, malleable iron fittings.
- B Copper Tube: ASTM B88 (ASTM B88M), Type K (A), 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. Tee Connections: Mechanically extracted collars with notched and dimpled branch tube.
  - 3. Mechanical Press Sealed Fittings: Double pressed type complying with ASME B16.22, utilizing EPDM, nontoxic synthetic rubber sealing elements.
    - a. Manufacturers:
      - 1) Apollo Valves: [www.apollovalves.com/#sle](http://www.apollovalves.com/#sle).
      - 2) FNW; Copper Press: [www.fnw.com/#sle](http://www.fnw.com/#sle).
      - 3) Grinnell Products: [www.grinnell.com/#sle](http://www.grinnell.com/#sle).

#### 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.

#### 2.04 UNIONS, FLANGES, MECHANICAL COUPLINGS, AND DIELECTRIC CONNECTIONS

- A Unions for Pipe of 2 Inches and Less:
  - 1. Copper Pipe: Bronze, soldered joints.
- B Flanges for Pipe 2 Inches and Greater:
  - 1. Copper Piping: Bronze.

#### 2.05 SWING CHECK VALVES

- A Manufacturers:
  - 1. Anvil International; \_\_\_\_\_: [www.anvilintl.com/#sle](http://www.anvilintl.com/#sle).
  - 2. Apollo Valves; \_\_\_\_\_: [www.apollovalves.com/#sle](http://www.apollovalves.com/#sle).
  - 3. Grinnell Products; \_\_\_\_\_: [www.grinnell.com/#sle](http://www.grinnell.com/#sle).
- B Up To and Including 2 Inches:

1. Bronze body, bronze trim, bronze rotating swing disc, with composition disc, solder ends.
- C Over 2 Inches:
  1. Iron body, bronze or \_\_\_\_\_ trim, stainless steel, bronze, bronze faced rotating, or \_\_\_\_\_ swing disc, renewable disc and seat, flanged, grooved, or \_\_\_\_\_ ends.

### **PART 3 EXECUTION**

#### **3.01 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 using jointing system specified.
- D Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.
- E After completion, fill, clean, and treat systems. See Section 23 25 00 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.

**END OF SECTION 23 21 13**

**SECTION 23 23 00**  
**REFRIGERANT PIPING**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A Piping.
- B Refrigerant.
- C Moisture and liquid indicators.
- D Valves.
- E Strainers.
- F Check valves.
- G Filter-driers.
- H Flexible connections.
- I Exterior penetration accessories.

**1.02 RELATED REQUIREMENTS**

- A Section 23 07 16 - HVAC Equipment Insulation.

**1.03 REFERENCE STANDARDS**

- A AHRI 710 (I-P) - Performance Rating of Liquid-Line Driers; 2009.
- B AHRI 711 (SI) - Performance Rating of Liquid-Line Driers; 2009.
- C AHRI 730 (I-P) - Flow Capacity Rating of Suction Line Filters and Suction Line Filter Driers; 2013 (Reapproved 2014).
- D AHRI 750 - Thermostatic Refrigerant Expansion Valves; 2007.
- E ASHRAE Std 15 - Safety Standard for Refrigeration Systems; 2019, with All Amendments and Errata.
- F ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators; 2023.
- G ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2021.
- H ASME B31.5 - Refrigeration Piping and Heat Transfer Components; 2022.
- I ASME B31.9 - Building Services Piping; 2020.
- J ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service; 2020.
- K AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding; 2019.
- L MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2018, with Amendment (2019).

**1.04 SUBMITTALS**

- A See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B Product Data: Provide general assembly of specialties, including manufacturer's catalogue information. Provide manufacturer's catalog data including load capacity.
- C Sustainable Design Documentation: Submit manufacturer's product data on refrigerant used, showing compliance with specified requirements.
- D Shop Drawings: Indicate schematic layout of system, including equipment, critical dimensions, and sizes.
- E Test Reports: Indicate results of leak test, acid test.
- F Manufacturer's Installation Instructions: Indicate support, connection requirements, and isolation for servicing.
- G Designer's qualification statement.
- H Installer's qualification statement.
- I Project Record Documents: Record exact locations of equipment and refrigeration accessories on record drawings.

**1.05 DELIVERY, STORAGE, AND HANDLING**

- A Deliver and store piping and specialties in shipping containers with labeling in place.
- B Protect piping and specialties from entry of contaminating material by leaving end caps and plugs in place until installation.
- C Dehydrate and charge components such as piping and receivers, seal prior to shipment, until connected into system.

## **PART 2 PRODUCTS**

### **2.01 SYSTEM DESCRIPTION**

- A Where more than one piping system material is specified ensure system components are compatible and joined to ensure integrity of system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.
- B Provide pipe hangers and supports in accordance with ASME B31.5 unless indicated otherwise.
- C Liquid Indicators:
  - 1. Use line size liquid indicators in main liquid line leaving condenser.
- D Valves:
  - 1. Use service valves on suction and discharge of compressors.
- E Refrigerant Charging (Packed Angle) Valve: Use in liquid line between receiver shut-off valve and expansion valve.
- F Strainers:
  - 1. Use line size strainer upstream of each automatic valve.
  - 2. Where multiple expansion valves with integral strainers are used, use single main liquid line strainer.
- G Pressure Relief Valves: Use on ASME receivers and pipe to outdoors.
- H Filter-Driers:
  - 1. Use a filter-drier immediately ahead of liquid-line controls, such as thermostatic expansion valves, solenoid valves, and moisture indicators.
  - 2. Use a filter-drier on suction line just ahead of compressor.
- I Solenoid Valves:
  - 1. Use in liquid line of single or multiple evaporator systems.

### **2.02 REGULATORY REQUIREMENTS**

- A Comply with ASME B31.9 for installation of piping system.
- B Welding Materials and Procedures: Comply with ASME BPVC-IX and applicable state labor regulations.
- C Welders Certification: In accordance with ASME BPVC-IX.
- D Products Requiring Electrical Connection: Listed and classified by UL, as suitable for the purpose indicated.

### **2.03 PIPING**

- A Copper Tube: ASTM B280, H58 hard drawn.
  - 1. Fittings: ASME B16.22 wrought copper.
  - 2. Joints: Braze, AWS A5.8M/A5.8 BCuP silver/phosphorus/copper alloy.
- B Pipe Supports and Anchors:
  - 1. Provide hangers and supports that comply with MSS SP-58.
    - a. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
  - 2. Hangers for Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
  - 3. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
  - 4. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
  - 5. Vertical Support: Steel riser clamp.
  - 6. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
  - 7. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
  - 8. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

### **2.04 REFRIGERANT**

- A Refrigerant: Use only refrigerants that have ozone depletion potential (ODP) of zero and global warming potential (GWP) of less than 50.

### **2.05 MOISTURE AND LIQUID INDICATORS**

- A Indicators: Single port type, UL listed, with copper or brass body, flared or soldered ends, sight glass, color coded paper moisture indicator with removable element cartridge and plastic cap; for maximum temperature of 200 degrees F and maximum working pressure of 500 psi.

## 2.06 VALVES

### A Ball Valves:

1. Two piece bolted forged brass body with teflon ball seals and copper tube extensions, brass bonnet and seal cap, chrome plated ball, stem with neoprene ring stem seals; for maximum working pressure of 500 psi and maximum temperature of 300 degrees F.

### B Service Valves:

1. Forged brass body with copper stubs, brass caps, removable valve core, integral ball check valve, flared or soldered ends, for maximum pressure of 500 psi.

## 2.07 STRAINERS

### A Manufacturers:

1. Hansen Technologies Corporation; \_\_\_\_\_: [www.hantech.com/#sle](http://www.hantech.com/#sle).
2. Parker Hannifin/Refrigeration and Air Conditioning; \_\_\_\_\_: [www.parker.com/#sle](http://www.parker.com/#sle).
3. Sporlan, a Division of Parker Hannifin; \_\_\_\_\_: [www.parker.com/#sle](http://www.parker.com/#sle).

### B Straight Line or Angle Line Type:

1. Brass or steel shell, steel cap and flange, and replaceable cartridge, with screen of stainless steel wire or monel reinforced with brass; for maximum working pressure of 430 psi.

## 2.08 CHECK VALVES

### A Manufacturers:

1. Hansen Technologies Corporation; \_\_\_\_\_: [www.hantech.com/#sle](http://www.hantech.com/#sle).
2. Parker Hannifin/Refrigeration and Air Conditioning; \_\_\_\_\_: [www.parker.com/#sle](http://www.parker.com/#sle).
3. Sporlan, a Division of Parker Hannifin; \_\_\_\_\_: [www.parker.com/#sle](http://www.parker.com/#sle).
4. \_\_\_\_\_.
5. Substitutions: See Section 01 60 00 - Product Requirements.

### B Straight Through Type:

1. Brass body and disc, phosphor-bronze or stainless steel spring, neoprene seat; for maximum working pressure of 500 psi and maximum temperature of 200 degrees F.

## 2.09 FILTER-DRIERS

### A Performance:

1. Flow Capacity - Liquid Line: As indicated in schedule, minimum, rated in accordance with AHRI 710 (I-P) (AHRI 711 (SI)).
2. Flow Capacity - Suction Line: As indicated in schedule, minimum, rated in accordance with AHRI 730 (I-P).
3. Pressure Drop: 2 psi, maximum, when operating at full connected evaporator capacity.
4. Design Working Pressure: 350 psi, minimum.

### B Cores: Molded or loose-fill molecular sieve desiccant compatible with refrigerant, activated alumina, activated charcoal, and filtration to 40 microns, with secondary filtration to 20 microns; of construction that will not pass into refrigerant lines.

### C Construction: UL listed.

1. Connections: As specified for applicable pipe type.

## 2.10 FLEXIBLE CONNECTORS

### A Corrugated stainless steel hose with single layer of stainless steel exterior braiding, minimum 9 inches long with copper tube ends; for maximum working pressure of 500 psi.

## 2.11 EXTERIOR PENETRATION ACCESSORIES

### A Flashing Panels for Exterior Wall Penetrations: Premanufactured components and accessories as required to preserve integrity of building envelope; suitable for conduits and facade materials to be installed.

### B Sealing Systems for Roof Penetrations: Premanufactured components and accessories as required to preserve integrity of roofing system and maintain roof warranty; suitable for conduits and roofing system to be installed; designed to accommodate existing penetrations where applicable.

## PART 3 EXECUTION

### 3.01 INSTALLATION

#### A Install refrigeration specialties in accordance with manufacturer's instructions.

#### B Route piping in orderly manner, with plumbing parallel to building structure, and maintain gradient.

- C Install piping to conserve building space and avoid interference with use of space.
- D Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- E Pipe Hangers and Supports:
  - 1. Install in accordance with ASME B31.5.
  - 2. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
  - 3. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
- F Provide clearance for installation of insulation and access to valves and fittings.
- G Insulate piping and equipment.
- H Follow ASHRAE Std 15 procedures for charging and purging of systems and for disposal of refrigerant.

**3.02 FIELD QUALITY CONTROL**

- A Test refrigeration system in accordance with ASME B31.5.
- B Pressure test system with dry nitrogen to 200 psi. Perform final tests at 27 inches vacuum and 200 psi using halide torch. Test and repair piping until no leakage.

**END OF SECTION 23 23 00**

**SECTION 23 31 00**  
**HVAC DUCTS AND CASINGS**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A Metal ducts.
- B Flexible ducts.

**1.02 REFERENCE STANDARDS**

- A ASHRAE (FUND) - ASHRAE Handbook - Fundamentals; Most Recent Edition Cited by Referring Code or Reference Standard.
- B ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.
- C ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2022.
- D ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2023.
- E ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2021a.
- F ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2018b.
- G NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2021.
- H SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2021.
- I SMACNA (LEAK) - HVAC Air Duct Leakage Test Manual; 2012.
- J UL 181 - Standard for Factory-Made Air Ducts and Air Connectors; current edition, including all revisions.

**1.03 SUBMITTALS**

- A Product Data: Provide data for duct materials and duct connections.
- B Shop Drawings: Indicate duct fittings, particulars such as gages, sizes, welds, and configuration prior to start of work for all systems.
  - 1. Clearly indicate which fittings shall be used on the project: elbows, wyes, takeoffs, transitions, offsets, etc.
- C Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate per appropriate seal class, following SMACNA (LEAK).

**1.04 QUALITY ASSURANCE**

- A Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience, and approved by manufacturer.
- B Galvanizing thickness and country of origin must be clearly stenciled on each duct section. At the discretion of the Engineer, sheet metal gauges and reinforcing may be randomly checked to verify all duct construction is in compliance.
- C Ductwork and fittings must have a computer generated label affixed to each section detailing the duct dimensions, sheet metal gauge, intermediate and joint reinforcement size, and the transverse connector brand and classification.

**1.05 FIELD CONDITIONS**

- A Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.
- B Maintain temperatures within acceptable range during and after installation of duct sealants.
- C If ductwork is stored on site, elevate duct above floors and maintain protection on ends.

**PART 2 PRODUCTS**

**2.01 GENERAL REQUIREMENTS**

- A Provide ductwork, fittings, hangers, supports, and appurtenances in accordance with NFPA 90A and SMACNA (DCS) guidelines unless stated otherwise.
- B Duct Sealing and Leakage in accordance with Static Pressure Class:
  - 1. Low Pressure Service: Up to 2 in-wc:
    - a. Seal: Class C, apply to seal off transverse joints.
    - b. Leakage:
      - 1) Rectangular: Class 16
      - 2) Round: Class 8
  - 2. Medium Pressure Service: 3 in-wc



- a. Seal: Class A, apply sealing of transverse joints, longitudinal seams, and duct wall penetrations.
- b. Leakage:
  - 1) Rectangular: Class 8 .
  - 2) Round: Class 4
3. Medium Pressure Service: 4 in-wc and above
  - a. Seal: Class A, apply sealing of transverse joints, longitudinal seams, and duct wall penetrations.
  - b. Leakage:
    - 1) Rectangular: Class 4
    - 2) Round: Class 2
- C Duct Fabrication Requirements:
  1. Duct and Fitting Fabrication and Support: SMACNA (DCS) including specifics for continuously welded round and oval duct fittings.
  2. Use reinforced and sealed sheet-metal materials at recommended gauges for indicated operating pressures or pressure class.
  3. Construct tees, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows must be used, provide airfoil turning vanes of perforated metal with glass fiber insulation.
  4. Provide turning vanes of perforated metal with glass fiber insulation when acoustical lining is indicated.
  5. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
  6. Provide turning vanes of perforated metal with glass fiber insulation when an acoustical lining is required.
  7. Where ducts are connected to exterior wall louvers and duct outlet is smaller than louver frame, provide blank-out panels sealing louver area around duct. Use same material as duct, painted black on exterior side; seal to louver frame and duct.
- D Duct transverse joints and reinforcement materials, including angle ring flanges and stiffeners, shall be of the same material as the duct.
- E Low Pressure Supply: 2 inch w.g. pressure class, galvanized steel.
- F Medium and High Pressure Supply: 4 inch w.g. pressure class, galvanized steel.
- G Return and Relief: -2 inch w.g. pressure class, galvanized steel.
- H General Exhaust: -2 inch w.g. pressure class, galvanized steel.
- I Outside Air Intake: -2 inch w.g. pressure class, galvanized steel.
- J Combustion Air: 1 inch w.g. pressure class, galvanized steel.
- K Transfer Air and Sound Boots: 1 inch w.g. pressure class.

## 2.02 MATERIALS

- A Galvanized Steel for Ducts: Hot-dipped galvanized steel sheet, ASTM A653/A653M FS Type B, with G90/Z275 coating.
- B Stainless Steel for Ducts: ASTM A666, Type 304.
- C "Paint Grip" Finish or Mill Phosphatized Steel (Exposed Ductwork):
  1. Galvanized G90 steel shall be put through a phosphate bath and have a layer of Chromate applied and dried leaving it ready to accept paint. This shall be done at the mill. The process produces a dull gray colored finish.
- D Joint Sealers and Sealants: Non-hardening, water resistant, mildew and mold resistant.
  1. Manufacturers:
    - a. Childers
    - b. Ductmate
    - c. Durodyne
    - d. Foster
    - e. Hardcast
    - f. McGill Airseal
    - g. Sheet Metal Connectors, Inc.

- h. Or Approved Equal
- 2. Flexible, water-based, adhesive sealant designed for use in all pressure duct systems. After curing, it shall be resistant to ultraviolet light and shall prevent the entry of water, air, and moisture into the duct system. Sealer shall be UL 723 and UL 181B-M listed and meet NFPA requirements for Class 1 ductwork. VOC shall be <75 g/l.
- 3. Neoprene gasket must be closed cell rubber based sealing tape and must pass UL 94 HF-1.
- 4. Butyl rubber gasket which complies with UL 723, Mil-C 18969B and TTS-S-001657. This material, in addition to the above, shall not contain vegetable oils, fish oils, or any other type vehicle that will support fungal and/or bacterial growth.
- 5. Surface Burning Characteristics: Flame spread index of zero and smoke developed index of zero, when tested in accordance with ASTM E84.
- E Hanger Rod: ASTM A36/A36M; steel, galvanized; threaded both ends, threaded one end, or continuously threaded.
- F Cable Suspension System:
  - 1. Suspension system shall be Gripple Hang-Fast as manufactured and supplied by Gripple, Inc., or Ductmate "Clutcher" cable hanging system.
  - 2. Suspension system shall be load rated and verified by SMACNA Testing and Research Institute to be in compliance with SMACNA Standards.
  - 3. All suspension systems shall used galvanized hardware.

### 2.03 DUCTWORK FABRICATION

- A Fabricate and support in accordance with SMACNA (DCS) and as indicated.
  - 1. Internal tie rods or bracing are not allowed for ductwork 36" and below. Tie rods shall be 1/2", 3/4", 1", 1-1/4" or 1-1/2" galvanized rods with bolt assembly consisting of rubber washer and friction anchored threaded insert similar to Ductmate Easyrod or PPI Condu-Lock.
  - 2. Internal tie rods are not allowed for ductwork in chase and other non-accessible locations.
- B Where the size for a duct segment is not indicated, the duct segment size shall be equal to the largest duct segment to which it is connected. Transition to smaller size shall occur on the side of the fitting where smaller size is indicated.
- C No variation of duct configuration or size permitted except by written permission. Size round duct installed in place of rectangular ducts in accordance with ASHRAE (FUND) Handbook - Fundamentals.
- D Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows must be used, provide air foil turning vanes of perforated metal with glass fiber insulation.
- E Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
- F Fabricate continuously welded round and oval duct fittings in accordance with SMACNA (DCS).
- G Where ducts are connected to exterior wall louvers and duct outlet is smaller than louver frame, provide blank-out panels sealing louver area around duct. Use same material as duct, painted black on exterior side; seal to louver frame and duct.

### 2.04 HANGERS AND SUPPORTS

- A Refer to the Structural Drawngs and Details for the limitations and applications of each type of hanger and weight when attaching to bar joists, trusses, or other building Structural elements. The Contractor shall be responsible for providing additional miscellaenous steel, unistrut, and other components to span multiple joists as required by the Structural Drawings to distribute concentrated loads.
- B Unless otherwise indicated, use straps or Z bar hangers with 3/8" rods to support rectangular ducts 48" wide and smaller and trapeze hangers with rods or angles to support rectangular ducts over 48" wide.
  - 1. Use trapeze hangers to support externally insulated ductwork with weight bearing inserts.
- C For round ducts 24" diameter or smaller, use single hanger.
  - 1. Cable Suspension System may be used up to 16" diameter
  - 2. Round Duct Strap Bracket by Ductmate Industries may be used up to 24" diameter.
- D For round ducts over 24" diameter, use 2 hangers with half round trapeze.
- E For round ducts over 25" diameter or larger, use 2 minimum 3/8" rods with trapeze.

- F The following upper attachments, upper attachment devices, lower hanger attachments, hanger devices, and/or hanger attachments are not allowed except where specifically indicated:
1. Hook or loop.
  2. Nailed pin fasteners.
  3. Expansion nails without washers.
  4. Powder charged or mechanically driven fasteners (forced entry anchors).
  5. Beam or "C" clamps without retaining clips or friction clamps (provide retaining clips for "C" clamps).
  7. Friction clamps for ductwork over 12".
  8. Non-factory manufactured upper attachments for metal pan deck including wire coil and double circle (Items 16 and 17 of Fig 4-3 of SMACNA HVAC Duct Construction Standards 95).
  9. Wire hanger.
  10. Trapeze hangers supported by wires or straps.
  11. Rods, straps or welded studs directly attached to metal deck.
  12. Drilled hole with attachment to structural steel.
  13. Lag screw expansion anchor.
  14. Rivets.
- G Supporting devices shall be standard products of manufacturers having published load ratings.
- H Unless drawings indicate the required framing, provide angle iron framing around roof opening where duct penetrates through roof decking, to maintain roof decking structural integrity in accordance with roof decking manufacturer's recommendations. This is not required for concrete decking. For concrete decking, consult with Structural Engineer for location and size of opening prior to execution of Work.
- I For welded ducts, soldered ducts or ducts with water tight joints, do not use supports utilizing screws or other penetrations into ductwork.
- J All hangers and supports shall be fully galvanized.

## **2.05 METAL DUCTS**

- A Material Requirements:
1. Galvanized Steel: Hot-dipped galvanized steel sheet, ASTM A653/A653M FS Type B, with G90/Z275 coating.
  2. Aluminum: ASTM B209/B209M, aluminum sheet, alloy 3003-H14.
- B Double Wall Insulated Round Ducts: Round spiral lockseam duct with galvanized steel outer wall, perforated galvanized steel inner wall; fitting with solid inner wall.
1. Manufacture in accordance with SMACNA (DCS).
  2. Insulation:
    - a. Thickness: 1 inch.
    - b. Material: Fiberglass or elastomeric foam.
    - c. Finish: "Paint grip" mill phosphatized
  3. Manufacturers:
    - a. MKT Metal Manufacturing
    - b. Hamlin
    - c. SMC
    - d. McGill Airflow
    - e. Or Approved Equal
- C Double Wall Insulated Rectangular Ducts: Rectangular spiral lockseam duct with galvanized steel outer wall, perforated galvanized steel inner wall; fitting with solid inner wall.
1. Manufacture in accordance with SMACNA (DCS).
  2. Insulation:
    - a. Thickness: 1 inch.
    - b. Material: Fiberglass or elastomeric foam.
    - c. Finish: "Paint grip" mill phosphatized
- D Spiral Ducts: Round spiral lockseam duct with galvanized steel outer wall.
1. Manufacture in accordance with SMACNA (DCS).

2. Manufacturers:
  - a. EHG, a DMI Company
  - b. GSI, a DMI Company
  - c. Linx Industries, Inc, a DMI Company
  - d. MKT Metal Manufacturing
  - e. Or Approved Equal

**2.06 FLEXIBLE DUCTS**

- A Flexible Air Ducts:
1. UL 181, Class 0, interlocking spiral of aluminum foil.
  2. Insulation: Fiberglass insulation with aluminized vapor barrier film.
  3. Pressure Rating: 8 in-wc positive or negative.
  4. Maximum Velocity: 5,000 fpm.
  5. Temperature Range: Minus 20 to 250 degrees F.

**2.07 LONGITUDINAL SEAM:**

- A Rectangular Duct:
1. Unless otherwise indicated, use Pittsburgh lock seam construction.
  2. Seal longitudinal seams with approved sealant or provide pre-sealed from factory with encapsulated mastic.
  3. Button punch snap lock construction (SMACNA L-2) is not allowed except for ductwork that is both low pressure (2" WG or lower pressure class) and 18" and smaller duct width.
  4. Button punch snap lock construction is not allowed for ductwork in chases and areas above inaccessible ceilings.
  5. Button punch snaplock construction is not allowed on exhaust ductwork or aluminum ductwork
- B Round and Oval Duct
1. Unless otherwise indicated, longitudinal seams shall be in accordance with SMACNA HVAC Duct Construction Standards with the following exceptions:
    - a. Snaplock seams are not allowed.
    - b. SMACNA seam types RL-3, 6A, 6B, 7, and 8 shown in Figure 3-2 are not allowed, except for 2" w.g. class round ducts 16" or less in diameter.

**2.08 RECTANGULAR TRANSVERSE JOINT CONNECTORS:**

- A Slide-on Transverse Joint Connectors:
1. Duct constructed using engineered slide-on connector systems must be submitted and conform to manufacturer's published duct construction standards and guidelines for joint classification, sheet metal gauge, intermediate and joint reinforcement size and spacing, unless otherwise specified.
  2. Manufacturer of engineered connector system must have certified independent performance testing for leakage, deflection and seismic stability.
  3. All components of the engineered system must be clearly embossed with the manufacturer's name, model number or identifying marking.
  4. Butyl rubber gasket must be applied per the manufacturer's instructions on all connections except for breakaway connections. Closed Cell Neoprene gasket must be applied per the manufacturer's instructions on all breakaway connections. No substitution of connector system components or gaskets is permitted.
  5. All duct installed using engineered connectors must adhere to the manufacturer's published assembly and installation guidelines for all standard, breakaway, roof-top or specialty connections unless otherwise specified.
- B Formed-on Flanges:
1. Lockformers TDC or Engles TDF may be used in accordance with T-25 flanges of SMACNA HVAC Duct Construction Standards, provided that corner pieces with bolts are used. If TDF/TDC flanges are damaged, replace the damaged joint(s) by straightening and reinforcing with minimum 1-1/2 x 1-1/2 x 1/4 angle at each side of transverse joint

## PART 3 EXECUTION

### 3.01 INSTALLATION

- A Install, support, and seal ducts in accordance with SMACNA (DCS).
- B During construction, provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering the ductwork system.
- C Install ductwork parallel to building walls and ceilings and at such heights not to obstruct any portion of window, doorway, stairway, or passageway. Install ductwork to allow adequate access and service space for equipment and access clearances for cable tray/j-hooks. Refer to drawings and/or manufacturer's recommendations. Install vertical ductwork plumb. Make allowances for beams, pipes or other obstructions in building construction and for work of other contractors. Check plans showing work of other trades and consult with Engineer in event of any interference.
- D Where interferences develop in the field, offset or reroute ductwork as required to clear such interferences. Do not divide duct and do not route any other utilities such as piping or conduit through duct. In all cases, consult drawings for exact location of space allocated for duct, ceiling heights, door and window openings, or other architectural details before fabricating or installing duct. Consult Designer where conflicts arise between ductwork and other utilities which cannot be resolved by relocating duct.
- E Where offsets in ductwork are required, contractor to use standard 30, 45 or 90-degree elbows. Where space constraints do not allow for the use of standard elbows for offsets, use of angled offsets as depicted by SMACNA Figure 2-7 (Angled Offset Type 1) may be used with maximum angle of offset not to exceed 15 degrees maximum. Offsets Type 2 and 3 in SMACNA Figure 2-7 shall not be allowed.
- F Rectangular Duct Elbows:
  - 1. Rectangular Duct: Unless specific type is indicated, provide radius elbows with splitter vanes with minimum centerline radius to width or diameter ratio of 1.5
    - a. 1.5 radius elbows with full splitter vanes as follows:
      - 1) One vane for duct width 2-12"
      - 2) Two vanes for duct width 13-20"
      - 3) Three vanes for duct width 21"-36"
      - 4) Four vanes for duct width 38" and larger
      - 5) Fabricate vanes in accordance with SMACNA.
    - b. Rectangular throat elbows with turning vanes where 1.5 radius elbows do not fit.
    - c. Rectangular throat/radius heel elbows or rectangular elbows without turning vanes shall not be used.
- G Round and Oval Duct Elbows:
  - 1. Unless specific type is indicated, use radius elbows with centerline radius to diameter ratio of 1.5. ONLY where 1.5 radius elbows do not fit, 1.0 radius elbows may be used if approved by the Engineer.
- H Construct ductwork so that interior surfaces are smooth. Internal duct hangers and internal bracing are not allowed. Refer to above for internal tie rods.
- I Support coils, filters, air terminals, dampers, sound attenuating devices, or other devices installed in duct systems with angles or channels and make all connections to such equipment including equipment furnished by others. Secure frames with gaskets, nuts, bolts and washers.
- J Flexible ducts shall not exceed 5 feet in length. Bends, kinks, and sagging of flexible duct will not be accepted. The maximum permitted sag is 1/2" per foot of support spacing.
- K Install outside air intake duct to pitch down at minimum 1" per 20 ft toward intake louver or plenum and to drain to outside of building. Solder or seal seams to form watertight joints.
- L Install exhaust air duct to pitch down at minimum 1" per 20 ft toward exhaust louver.
- M Where 2 different metal ducts meet, install joint in such a manner that metal ducts do not contact each other by using proper gasket seal or compound.
- N Flexible Ducts: Connect to metal ducts with adhesive plus sheet metal screws.
  - 1. Flexible ducts are not allowed for special exhaust systems, such as laboratory exhaust, vehicle exhaust, etc.
  - 2. Splicing of flexible duct will not be allowed.
  - 3. Flexible ducts shall not pass through any partition, wall, floor, or ceiling.

- O Residential Clothes Dryer Exhaust Duct: Provide stenciled label. Label shall indicate the following:
  - 1. Equivalent length ----- feet. Any installed dryer must be equipped with an exhaust system that meets or exceeds this equivalent length requirement.
- P All ducts conveying hazardous or flammable vapors shall be labeled via stencilled painting or permanent nameplates. Labels shall be every 10 feet where above accessible ceilings or in mechanical rooms or on roof.
- Q Duct sizes indicated are precise inside dimensions. For lined ducts, maintain sizes inside lining.
- R Provide openings in ductwork as indicated to accommodate thermometers and controllers. Provide pilot tube openings as indicated for testing of systems, complete with metal can with spring device or screw to insure against air leakage. For openings, insulate ductwork and install insulation material inside a metal ring.
- S Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- T All exposed ductwork to be painted shall be mill bonderized or "paint grip." The contractor shall thoroughly clean all ductwork surfaces to be free from oils, grease, lubricants, and other contaminants prior to application of paint. Follow
- U Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized steel primer.
- V Use double nuts and lock washers on threaded rod supports.
- W Connect terminal units to supply ducts with hard duct. Maintain minimum three (3) feet or three (3) duct diameters (whichever is greater) of straight duct prior to inlet of box. Connecting flex duct to the inlets of terminal units will NOT be acceptable.
- X Provide minimum 5 ft of straight duct on outlet side of VAV boxes before first tap.
- Y At exterior wall louvers, seal duct to louver frame and install blank-out panels.
- Z All trapeze hanger rods shall be cut to within 1" of the bottom nut.

### 3.02 DUCT LEAKAGE TESTING

- A All transverse joints and longitudinal seams shall conform to SMACNA's Class A sealing requirements as defined in the SMACNA Manual.
- B Ductwork Sealing: As a minimum standard, ductwork and plenums shall be sealed in accordance with Table 6.2.4.3A of ASHRAE Standard 90.1 (as required to meet the requirements of Section 6.2.4.4 SMACNA Duct Leakage Test Procedures).
- C Prove tightness of duct construction by operating air handling equipment and physically verifying absence of any air leakage, both audibly and manually. Repair as needed to achieve minimal leakage. Examine every joint and verify leak tight. If further testing is needed to resolve duct leakage problems, particularly as related to sound criteria, comply with procedure outline in 1985 (or current edition) of SMACNA HVAC Air Duct Leakage Test Manual.
- D Ductwork constructed to 3" w.g. pressure class (positive or negative) or higher shall be leak-tested according to the SMACNA HVAC Air Leakage Test Manual. All sections shall be tested, unless otherwise noted.
- E The Test Pressure for each system shall be equal to the construction pressure class the respective duct system is constructed to.
- F Maximum permitted duct leakage shall be:
  - 1.  $L_{max} = CL \times \text{Test Pressure "P" raised to the 0.65 power}$  where  $L_{max}$  is maximum permitted leakage in CFM/100 sq. ft. duct surface area
    - a. CL is duct leakage class
    - b. P is test pressure, equal to the duct construction pressure class in inches w.c.
- G Duct Air Leakage Testing (DALT):
  - 1. Installed ductwork shall be tested prior to installation of access doors, take-offs etc.
  - 2. All testing shall be witnessed by the engineer or owner's representative. Contractor shall give the engineer or owner's representative 72 hours' notice prior to testing.
  - 3. The testing shall be performed as follows:
    - a. Perform testing in accordance with SMACNA HVAC Air Duct Leakage Test Manual.
    - b. Use a certified orifice tube for measuring the leakage.
    - c. Define section of system to be tested and blank off.
    - d. Determine the percentage of the system being tested.
    - e. Using that percentage, determine the allowable leakage (CFM) for that section being used.

- f. Pressurize to operating pressure and repair any significant or audible leaks.
- g. Re-pressurize and measure leakage.
- h. Repeat steps 6 and 7 until the leakage is less than the allowable defined in step 5.

**END OF SECTION 23 31 00**

**SECTION 23 33 00**  
**AIR DUCT ACCESSORIES**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A Backdraft dampers - metal.
- B Combination fire and smoke dampers.
- C Duct access doors.
- D Duct test holes.
- E Fire dampers.
- F Flexible duct connectors.
- G Volume control dampers.
- H Miscellaneous products:
  - 1. Internal strut end plugs.
  - 2. Duct opening closure film.

**1.02 REFERENCE STANDARDS**

- A NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2021.
- B NFPA 92 - Standard for Smoke Control Systems; 2021, with Amendment.
- C NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations; 2021.
- D SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2021.
- E UL 33 - Safety Heat Responsive Links for Fire-Protection Service; Current Edition, Including All Revisions.
- F UL 555 - Standard for Fire Dampers; Current Edition, Including All Revisions.
- G UL 555S - Standard for Smoke Dampers; Current Edition, Including All Revisions.

**1.03 SUBMITTALS**

- A Product Data: Provide for shop fabricated assemblies including volume control dampers. Include electrical characteristics and connection requirements.
- B Manufacturer's Installation Instructions: Provide instructions for fire dampers and combination fire and smoke dampers.
- C Project Record Drawings: Record actual locations of access doors and test holes.
- D Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
  - 1. Extra Fusible Links: One of each type and size.

**1.04 QUALITY ASSURANCE**

- A Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum five years of documented experience.
- B Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.
- C All dampers shall be certified to bear the AMCA Certified Ratings Program seal for Air Performance, Efficiency, and Air Leakage.

**1.05 DELIVERY, STORAGE, AND HANDLING**

- A Protect dampers from damage to operating linkages and blades.
- B Storage: Store materials in a dry area indoor, protected from physical damage and in accordance with manufacturer's instructions.

**PART 2 PRODUCTS**

**2.01 AIR TURNING DEVICES/EXTRACTORS**

- A Manufacturers:
  - 1. Carlisle HVAC Products
  - 2. Elgen Manufacturing, Inc
  - 3. Ruskin Company
  - 4. Titus HVAC, a brand of Johnson Controls
  - 5. Ward Industries, a brand of Hart and Cooley, Inc
  - 6. Or Approved Equal
- B Multi-blade device with blades aligned in short dimension; steel construction; with individually adjustable blades, mounting straps.



## 2.02 BACKDRAFT DAMPERS - METAL

- A Manufacturers:
  - 1. Nailor Industries, Inc
  - 2. Ruskin Company, a brand of Johnson Controls
  - 3. United Enertech
  - 4. Greenheck
  - 5. Arrow
  - 6. Or Approved Equal
- B Frames shall be flanged, a minimum of 3 inches wide, and a minimum of 20 gauge roll formed galvanized steel or 0.125 inch extruded aluminum with pre-punched mounting holes and welded corner clips for maximum rigidity.
- C Blades shall be single piece, with a maximum width of 6 inches, counter balanced, and shall be constructed of minimum 26 gauge roll formed galvanized steel or 0.070 inch extruded aluminum. Blade ends shall overlap for maximum weather protection.
- D Blade seals shall be extruded vinyl and mechanically attached to blade edge.
- E Bearings shall be corrosion resistant synthetic.
- F Linkages shall use a galvanized tie bar with stainless steel pivot pins.
- G Axles shall be stainless steel.
- H Mounting shall be suitable for the required orientation.

## 2.03 DUCT AIR TURNING VANES

- A Provide factory manufactured turning vanes in each elbow where inside radius is less than the width of the duct, and in all square or rectangular elbows.
- B Turning vane assemblies shall be adequately supported and affixed to prevent rattling, breakaway, and shall not deform. Assemblies longer than 12 inches shall be double wall.
- C Turning vanes in negative pressure ductwork with pressure rating above 2 inches shall be installed in accordance with SMACNA Industrial Duct Construction Standard.
- D Turning vanes shall match the duct material construction.
- E Rectangular Throat Elbow Turning Vanes (Vane Runner Length up to 18" and Vane Length up to 36")
  - 1. Provide single blade type vanes having 2" radius and 1-1/2" spacing, 24 gauge minimum. Construct vanes in accordance with SMACNA HVAC Duct Construction Standards.
  - 2. If duct size changes in mitered elbow, use single blade type vanes with trailing edge extension.
- F Rectangular Throat Elbow Turning Vanes (Vane Runner Length up to 18" and Vane Length up to 36"):
  - 1. Use double wall airfoil type with smoothly-rounded entry nose and extended trailing edge on 2.4" center spacing.
  - 2. Vanes shall be equal to HEP (High Efficiency Profile) vanes as manufactured by Aero/Dyne Co.
- G Radius Elbow Splitter Vanes:
  - 1. Splitter vanes for radius elbows shall be extended entire length of fitting and constructed in accordance with SMACNA HVAC Duct Construction Standards.
- H Manufacturers:
  - 1. Aero Dyne
  - 2. Ductmate, Inc.
  - 3. Sheet Metal Connectors, Inc.
  - 4. Duro-Dyne
  - 5. DynAir Inc.
  - 6. Or Approved Equal

## 2.04 WIRE MESH SCREENS

- A Screen assemblies shall be removable.
- B Mesh: 1/2 inch square pattern, 1/16 inch galvanized wire, interwoven, welded at wire intersections and to the frame to prevent rattles.
- C Frames: Minimum of 1 inch by 1 inch by 1/8 inch galvanized steel angles for duct sizes through 24 inches, 1-1/2 inch by 1-1/2 inch by 3/16 inch for duct sizes between 25 inches and 48 inches, and 2 inches by 2 inches for ducts larger than 48 inches continuous around perimeter of screen. Provide intermediate supports

to limit screen deflection to 1/16 inch at maximum design airflow.

## 2.05 COMBINATION FIRE AND SMOKE DAMPERS

- A Manufacturers:
  - 1. Air Balance/ABI
  - 2. Nailor Industries, Inc
  - 3. NCA, a brand of Metal Industries Inc
  - 4. Pottorff
  - 5. Ruskin Company, a brand of Johnson Controls
  - 6. United Enertech
  - 7. Metal Industries
  - 8. ATI Industries
  - 9. Or Approved Equal
- B Fabricate in accordance with NFPA 90A, UL 555, UL 555S, and as indicated.
- C Provide factory sleeve and collar for each damper. Minimum 20 gauge thickness. Silicon caulk factory applied to sleeve at damper frame to comply with leakage rating requirements.
- D UL 555S Leakage Rating: Class 1 (8 CFM at 4 in. w.g. differential pressure)
- E Maximum Velocity: 4000 fpm
- F Maximum Pressure: 8 in w.g.
- G Maximum Pressure Drop: The maximum allowable pressure drop across the damper shall not exceed 0.15 in w.g. at 2000 FPM.
- H Frame: 5 inches x minimum 16 gage roll formed, galvanized steel hat-shaped channel, reinforced at corners. Structurally equivalent to 13 gage (2.3 mm) U-channel type frame.
  - 1. Provide single section construction for duct sizes up to 48x30. Section shall be equivalent to duct opening indicated on Drawings.
- I Blades:
  - 1. Style: True airfoil-shaped, single piece, double skin.
  - 2. Action: Opposed.
  - 3. Material: Minimum 14 gage equivalent thickness, galvanized steel.
  - 4. Width: Maximum 6 inches.
  - 5. Orientation: Vertical or Horizontal
- J Bearings: Self-lubricating stainless steel sleeve, turning in extruded hole in frame.
- K Seals:
  - 1. Inflatable silicone fiberglass material to maintain smoke leakage rating to a minimum of 450 degrees F and galvanized steel for flame seal to 1,900 degrees F. Mechanically attached to blade edge (glue-on or grip type seals are not acceptable).
  - 2. Jamb: Stainless steel, flexible metal compression type.
- L Linkage: Concealed in frame.
- M Axles: Minimum 1/2 inch diameter plated steel, hex-shaped, mechanically attached to blade.
- N Mounting: Vertical and/or Horizontal.
- O Operators: UL listed and labelled spring return electric type suitable for 120 volts, single phase, 60 Hz. Provide end switches to indicate damper position. Locate damper operator on exterior of duct and link to damper operating shaft.
- P Normally Closed Smoke Responsive Fire Dampers: Curtain type, opening by gravity upon actuation of electro thermal link, flexible stainless steel blade edge seals to provide constant sealing pressure.
- Q Provide damper test switch accessory for cycle testing.
- R Provide optional auxiliary switch package to allow remote indication of damper blade position.
- S Electro Thermal Link: Fusible link melting at 165 degrees F; 120 volts, single phase, 60 Hz; UL listed and labeled.

## 2.06 FLEXIBLE DUCT 90° ELBOW SUPPORT

- A Manufacturers:
  - 1. Build Right Products
  - 2. Hart and Cooley

3. Thermaflex
  4. Or Approved Equal
- B Pre-manufactured support to form any brand flexible duct into a smooth 90 degree elbow.
1. One size shall fit 4" to 16" flexible ducts
  2. No additional tools shall be required for installation
  3. UL listed for use in Return Air Plenums

## 2.07 DUCT ACCESS DOORS

- A Manufacturers:
1. Acudor Products Inc, a Division of Nelson Industrial Inc
  2. Ductmate Industries, Inc, a DMI Company
  3. Durodyne
  4. Elgen Manufacturing
  5. MKT Metal Manufacturing
  6. Nailor Industries Inc
  7. Ruskin Company
  8. SEMCO LLC
  9. Or Approved Equal
- B Fabrication: Rigid and close-fitting of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ducts, install minimum 1 inch thick insulation with sheet metal cover.
1. Up to 18 inches Square: Provide two hinges and two sash locks.
  2. Up to 24 by 48 inches: Three hinges and two compression latches with outside and inside handles.
- C Access doors with sheet metal screw fasteners are not acceptable.
- D Provide access doors of adequate size to allow easy access to the equipment that will require maintenance. Provide insulated or acoustically lined doors to prevent condensation where applicable.
- E Manufacturer shall provide a neoprene gasket around perimeter of access door for airtight seal.
- F Systems 2" w.g. or less shall use a hinged, cam, or hinged & cam square framed access door.
- G Systems 3" w.g. and above shall use a sandwich type access door. Construct doors in accordance with Figure 7-3 of the 2005 SMACNA Manual, "HVAC Duct Construction Standards, Metal & Flexible," Third Edition. Doors shall be rated for +/- 10" w.g.

## 2.08 DUCT TEST HOLES

- A Temporary Test Holes: Cut or drill in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.
- B Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.

## 2.09 FIRE DAMPERS

- A Manufacturers:
1. Nailor Industries Inc
  2. NCA, a brand of Metal Industries Inc
  3. Pottorff
  4. Ruskin Company
  5. United Enertech
  6. Air Balance/ABI
  7. Greenheck
  8. Metal Industries
  9. Prefco
  10. ATI Industries
  11. Or Approved Equal
- B Fabricate in accordance with NFPA 90A and UL 555, and as indicated.
- C Fire Resistance: 1-1/2 hours or 3 hours as required by assembly rating.
- D Dynamic Closure Rating: Dampers shall be classified for dynamic closure to 4000 fpm and 4 inches w.g. static pressure.
- E Construction:

1. Integral Sleeve Frame: Minimum 20 gauge roll formed galvanized steel. Sleeve length to be determined by Contractor for each condition.
  2. Blades:
    - a. Curtain type
    - b. Action: Spring or gravity closure upon fusible link release.
    - c. Orientation: Horizontal.
    - d. Material: Minimum 24 gage roll formed, galvanized steel.
  3. Closure Springs: Type 301 stainless steel, constant force type, if required.
  4. Mounting: Vertical and/or Horizontal.
  5. Duct Transition Connection, Damper Style:
    - a. B style – rectangular connection, blades out of air stream, high free area.
    - b. G style – A style connection, grille mounting tabs at end of sleeve for grille.
    - c. CR style – round connection, sealed.
  6. Finish: Mill galvanized.
- F Fusible Links: UL 33, separate at 165 degrees F with adjustable link straps for combination fire/balancing dampers.
- G Breakaway Connection:
  1. Ductmate or Drivemate.

## 2.10 FLEXIBLE DUCT CONNECTORS

- A Manufacturers:
  1. Carlisle HVAC Products
  2. Ductmate Industries, Inc, a DMI Company
  3. Elgen Manufacturing, Inc
  4. Durodyne
  5. Or Approved Equal
- B Flexible duct connector shall be used where ductwork connects to fan apparatus or fan casings to isolate vibration transfer. Connectors shall be attached in such a manner as to provide an airtight and waterproof seal.
- C Connectors will comply with NFPA 90A, "Installation of Air Conditioning & Ventilation Systems" and NFPA 90B, "Installation of Warm Air Heating & Air Conditioning Systems".
- D Connector fabrics shall meet NFPA 701 (formerly UL 214.)
- E Connector fabrics shall be mildew resistant per ASTM G21.
- F Indoor installations shall be NFPA 701 listed, fire retardant Vinyl coated woven nylon or Neoprene coated woven fiberglass fabric. Minimum density of Vinyl is 20 oz. /sq. yd. and rated to 200F. Minimum density of Neoprene 30 oz. / sq. yard and rated to 200F.
- G Outdoor installations shall be NFPA 701 listed UV-resistant Hypalon coated woven fiberglass fabric. Minimum density 24 oz. /sq. yd. and rated to 250F.
- H High temperature applications shall be NFPA 701 listed, Silicone coated satin weave fiberglass fabric. Minimum density 17.5 oz. /sq. yd. and rated to 500 F.
- I Chemical resistant applications shall be of Teflon coated woven fiberglass fabric. Minimum density 18 oz. /sq. yd. and rated to 500 F.
- J Fabricate in accordance with SMACNA (DCS) and as indicated.
- K Flexible Duct Connections: Fabric crimped into metal edging strip.

## 2.11 VOLUME CONTROL DAMPERS

- A Manufacturers:
  1. MKT Metal Manufacturing
  2. Nailor Industries Inc
  3. NCA, a brand of Metal Industries Inc
  4. Ruskin Company:
  5. United Enertech
  6. Greenheck
  7. Pottorff

8. Johnson Controls
9. Air Balance, Inc.
10. Or Approved Equal
- B Fabricate in accordance with SMACNA (DCS) and as indicated.
- C Round Control Damper - 1 in w.g. and below:
  1. Velocity: Up to 2,000 fpm
  2. Temperature: 180°F
  3. Construction:
    - a. Frame Material - Galvanized Steel
    - b. Frame Thickness: 20 gauge
    - c. Blade Material: Galvanized Steel
    - d. Axle Bearings: Bronze
    - e. Axle Material: Plated Steel
    - f. Operator: 3/8 inch sq. locking manual quadrant.
      - 1) On insulated ducts, provide 2 inch standoff bracket
    - g. Manufacturers:
      - 1) Greenheck MBDR-50
      - 2) Ruskin
      - 3) Nailor
- D Round Control Damper - 4 in w.g. and below:
  1. Velocity: Up to 3,000 fpm
  2. Temperature: 180°F
  3. Leakage: 4 cfm/ft<sup>2</sup> @ 1 in. wg
  4. Construction:
    - a. Frame Material - Galvanized Steel
    - b. Frame Thickness: 20 gauge
    - c. Blade Material: Galvanized Steel
    - d. Blade seal: Silicone
    - e. Axle Bearings: Bronze
    - f. Axle Material: Plated Steel
    - g. Operator: 3/8 inch sq. locking manual quadrant.
      - 1) On insulated ducts, provide 2 inch standoff bracket
  5. Manufacturers:
    - a. Greenheck VCDR-53
    - b. Ruskin
    - c. Nailor
- E Rectangular Single Blade Dampers: 1 in w.g. and below, up to 10 x 30 inch duct
  1. Velocity: Up to 2,000 fpm
  2. Temperature: 180°F
  3. Construction:
    - a. Frame Material - Galvanized Steel
    - b. Frame Thickness: 20 gauge
    - c. Blade Material: Galvanized Steel
    - d. Axle Bearings: Synthetic sleeve type
    - e. Axle Material: Plated Steel
    - f. Operator: 3/8 inch sq. locking manual quadrant, 2-1/2 inch long extension
      - 1) On insulated ducts, provide 2 inch standoff bracket
  4. Manufacturers:
    - a. Greenheck MBD-10M
    - b. Ruskin
    - c. Nailor
- F Rectangular Multi-Blade Balancing Dampers: 2 in w.g. and below

1. Pressure: Up to 4 in w.g.
2. Velocity: 2,000 fpm
3. Temperature: 180°F
4. Construction:
  - a. Frame Material - Galvanized Steel
  - b. Frame Thickness: 16 gauge
  - c. Blade Material: Galvanized Steel
  - d. Blade Thickness: 16 gauge
  - e. Blade Type: 3V
  - f. Blade Operation: Opposed
  - g. Axle Bearings: Synthetic sleeve type
  - h. Axle Material: Plated Steel
  - i. Operator: 1/2 inch locking manual quadrant, 1-1/2 inch long standoff bracket
  - j. Extension Pin: 1/2 inch diagonal glass reinforced polymer extends 3-1/2 inch beyond frame
5. Manufacturers:
  - a. Greenheck MBD-15
  - b. Ruskin
  - c. Nailor

G Quadrants:

1. Provide locking, indicating quadrant regulators on single and multi-blade dampers.
2. On insulated ducts mount quadrant regulators on stand-off mounting brackets, bases, or adapters.
3. Where rod lengths exceed 30 inches provide regulator at both ends.

**2.12 MISCELLANEOUS PRODUCTS**

- A Internal Strut End Plugs: Combination end-mounting and sealing plugs for metal conduit used as internal reinforcement struts for metal ducts; plug crimped inside conduit with outside gasketed washer seal.
- B Duct Opening Closure Film: Mold-resistant, self-adhesive film to keep debris out of ducts during construction.
1. Thickness: 2 mils.
  2. High tack water based adhesive.
  3. UV stable light blue color.
  4. Elongation Before Break: 325 percent, minimum.
  5. Manufacturers:
    - a. Carlisle HVAC Products; Dynair Duct Protection Film
    - b. Surface Shields
    - c. Trimaco
    - d. Ductmate ProGuard
    - e. Or Approved Equal

**PART 3 EXECUTION**

**3.01 INSTALLATION**

- A Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA (DCS). Refer to Section 23 31 00 for duct construction and pressure class.
- B Provide backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.
- C Provide a pre-manufactured support at each diffuser to turn the flex duct into a 90° elbow.
- D Contractor shall identify balancing dampers above the ceiling by either spray painting them bright orange or hanging an orange flag from the damper handle. If hanging a flag in a return air plenum, material shall comply with fire and smoke spread ratings for plenum use.
- E All fire dampers, smoke dampers, and combination fire/smoke dampers shall be installed with bottom edge 24" maximum above lay-in ceiling.
- F All balancing dampers shall be installed maximum 30" above the lay-in ceiling.
- G Provide duct access doors for inspection and cleaning before and after filters, coils, fans, automatic dampers, at fire dampers, combination fire and smoke dampers, and elsewhere as indicated. Provide minimum 12 by 12 inch size for hand access, size for shoulder access, and as indicated. Provide 8 by 8 inch for balancing

- dampers only. Review locations prior to fabrication.
- H Provide duct test holes where indicated and required for testing and balancing purposes.
  - I Provide fire dampers, combination fire and smoke dampers, and smoke dampers at locations indicated, where ducts and outlets pass through fire rated components. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.
  - J Install smoke dampers and combination smoke and fire dampers in accordance with NFPA 92.
  - K The Contractor shall inspect and test all fire dampers, smoke dampers, and combination fire/smoke dampers in accordance with NFPA 80 in the presence of the Authority Having Jurisdiction.
  - L Demonstrate re-setting of fire dampers to Owner's representative.
  - M At fans and motorized equipment associated with ducts, provide flexible duct connections immediately adjacent to the equipment.
  - N At equipment supported by vibration isolators, provide flexible duct connections immediately adjacent to the equipment.
    - 1. Refer to Section 23 05 48.
  - O Provide balancing dampers at points on supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing. Install minimum 2 duct widths from duct take-off.
  - P Provide balancing dampers on duct take-off to diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly.

**END OF SECTION 23 33 00**

**SECTION 23 34 23**  
**HVAC POWER VENTILATORS**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A Roof exhausters.
- B Cabinet exhaust fans.

**1.02 RELATED REQUIREMENTS**

- A Section 23 05 13 - Common Motor Requirements for HVAC Equipment.
- B Section 23 05 48 - Vibration and Seismic Controls for HVAC.
- C Section 23 31 00 - HVAC Ducts and Casings.
- D Section 23 33 00 - Air Duct Accessories: Backdraft dampers.

**1.03 REFERENCE STANDARDS**

- A AMCA (DIR) - (Directory of) Products Licensed Under AMCA International Certified Ratings Program; 2015.
- B AMCA 99 - Standards Handbook; 2016.
- C AMCA 204 - Balance Quality and Vibration Levels for Fans; 2020.
- D AMCA 210 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating; 2016.
- E AMCA 300 - Reverberant Room Method for Sound Testing of Fans; 2014.
- F AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data; 2022.

**1.04 SUBMITTALS**

- A See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B Product Data: Provide data on fans and accessories, including fan curves with specified operating point plotted, power, rpm, sound power levels at rated capacity, and electrical characteristics and connection requirements.
- C Manufacturer's Instructions: Indicate installation instructions.
- D Maintenance Data: Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.
- E Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
  - 1. See Section 01 60 00 - Product Requirements, for additional provisions.
  - 2. Extra Fan Belts: One set for each individual fan.

**PART 2 PRODUCTS**

**2.01 MANUFACTURERS**

- A Carnes, a division of Carnes Company Inc; \_\_\_\_\_: [www.carnes.com/#sle](http://www.carnes.com/#sle).
- B Greenheck Fan Corporation; \_\_\_\_\_: [www.greenheck.com/#sle](http://www.greenheck.com/#sle).
- C Loren Cook Company; \_\_\_\_\_: [www.lorencook.com/#sle](http://www.lorencook.com/#sle).

**2.02 POWER VENTILATORS - GENERAL**

- A Static and Dynamically Balanced: Comply with AMCA 204.
- B Performance Ratings: Comply with AMCA 210, bearing certified rating seal.
- C Sound Ratings: Comply with AMCA 301, tested to AMCA 300, bearing certified sound ratings seal.
- D Fabrication: Comply with AMCA 99.
- E Electrical Components: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

**2.03 ROOF EXHAUSTERS**

- A Manufacturers:
  - 1. Carnes, a division of Carnes Company Inc; VEBK, VEDK: [www.carnes.com/#sle](http://www.carnes.com/#sle).
  - 2. Greenheck Fan Corporation; G , GB: [www.greenheck.com/#sle](http://www.greenheck.com/#sle).
- B Basis of Design: Greenheck Fan Corporation; [www.greenheck.com](http://www.greenheck.com)
  - 1. Belt Drive, Down-Blast Discharge: G.
  - 2. Direct Drive, Down-Blast Discharge: GB
- C Fan Unit: V-belt or direct driven as indicated, with spun aluminum housing; resilient mounted motor; 1/2 inch mesh, 0.62 inch thick aluminum wire birdscreen; square base to suit roof curb with continuous curb gaskets.



- D Roof Curb: 8 inch high self-flashing of galvanized steel with continuously welded seams, built-in cant strips.
- E Disconnect Switch: Factory wired, nonfusible, in housing for thermal overload protected motor.
- F Backdraft Damper: Gravity actuated, aluminum multiple blade construction, felt edged with offset hinge pin, nylon bearings, blades linked.
- G Performance Ratings: As indicated on drawings.

#### **2.04 CABINET EXHAUST FANS**

- A Manufacturers:
  - 1. Carnes, a division of Carnes Company Inc; VCDD: [www.carnes.com/#sle](http://www.carnes.com/#sle).
  - 2. Greenheck Fan Corporation; SP: [www.greenheck.com/#sle](http://www.greenheck.com/#sle).
- B Centrifugal Fan Unit: V-belt or direct driven with galvanized steel housing lined with acoustic insulation, resiliently mounted motor, gravity backdraft damper in discharge.
- C Disconnect Switch: Cord and plug-in housing for thermal overload protected motor and unit mounted speed controller.
- D Grille: Molded white plastic.
- E Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheaves selected so required rpm is reached with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.
- F Performance Ratings: As indicated on drawings.

### **PART 3 EXECUTION**

#### **3.01 INSTALLATION**

- A Install in accordance with manufacturer's instructions.
- B Secure roof exhausters with cadmium plated steel lag screws to roof curb.
- C Extend ducts to roof exhausters into roof curb. Counterflash duct to roof opening.
- D Hung Cabinet Fans:
  - 1. Install fans with resilient mountings and flexible electrical leads, see Section 23 05 48.
  - 2. Install flexible connections between fan and ductwork; see Section 23 33 00. Ensure metal bands of connectors are parallel with minimum 1 inch flex between ductwork and fan while running.

**END OF SECTION 23 34 23**

**SECTION 23 37 00**  
**AIR OUTLETS AND INLETS**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A Diffusers:
- B Rectangular ceiling diffusers.
- C Registers/grilles:
  - 1. Ceiling-mounted, exhaust and return register/grilles.
  - 2. Ceiling-mounted, supply register/grilles.
  - 3. Wall-mounted, supply register/grilles.
  - 4. Wall-mounted, exhaust and return register/grilles.
- D Fabric air distribution devices.
- E Louvers:

**1.02 RELATED REQUIREMENTS**

- A Section 09 91 23 - Interior Painting: Painting of ducts visible behind outlets and inlets.

**1.03 REFERENCE STANDARDS**

- A AMCA 550 - Test Method for High Velocity Wind Driven Rain Resistant Louvers; 2022.
- B ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2018b.
- C NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2021.
- D NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems; 2021.
- E UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.
- F UL 2518 - Standard for Safety Air Dispersion Systems; Current Edition, Including All Revisions.

**1.04 SUBMITTALS**

- A See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B Product Data: Provide data for equipment required for this project. Review outlets and inlets as to size, finish, and type of mounting prior to submission. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.
- C Project Record Documents: Record actual locations of air outlets and inlets.

**PART 2 PRODUCTS**

**2.01 MANUFACTURERS**

- A Carnes, a division of Carnes Company Inc: [www.carnes.com/#sle](http://www.carnes.com/#sle).
- B Krueger-HVAC: [www.krueger-hvac.com/#sle](http://www.krueger-hvac.com/#sle).
- C Price Industries: [www.price-hvac.com/#sle](http://www.price-hvac.com/#sle).
- D Ruskin Company: [www.ruskin.com/#sle](http://www.ruskin.com/#sle).
- E Titus, a brand of Air Distribution Technologies: [www.titus-hvac.com/#sle](http://www.titus-hvac.com/#sle).

**2.02 RECTANGULAR CEILING DIFFUSERS - TYPE MARY ON SCHEDULE - A,B,C AND D**

- A Manufacturers:
  - 1. Krueger-HVAC; 1400: [www.krueger-hvac.com/#sle](http://www.krueger-hvac.com/#sle).
  - 2. Price Industries Inc; SCD: [www.price-hvac.com/#sle](http://www.price-hvac.com/#sle).
- B Type: Provide rectangular and square formed adjustable, backpan stamped, core removable, and multi-louvered ceiling diffusers constructed to maintain 360 degree discharge air pattern with sectorizing baffles where indicated.
- C Frame: Provide surface mount, snap-in, inverted T-bar, and spline type. In plaster ceilings, provide plaster frame and ceiling frame.
- D Fabrication: Steel with baked enamel finish.
- E Color: White.
- F Accessories: Provide opposed blade volume control damper; equalizing grid and gaskets for surface mounted diffusers with damper adjustable from diffuser face.

**2.03 CEILING SUPPLY REGISTERS/GRILLES**

- A Manufacturers:
  - 1. Krueger-HVAC; 880: [www.krueger-hvac.com/#sle](http://www.krueger-hvac.com/#sle).

2. Price Industries Industries; 540: [www.price-hvac.com/#sle](http://www.price-hvac.com/#sle).

- B Type: Streamlined and individually adjustable curved blades to discharge air along face of grille, two-way deflection.
- C Frame: 1-1/4 inch margin with countersunk screw mounting and gasket.
- D Construction: Made of steel with factory enamel finish.
- E Construction: Made of steel.
- F Color: white.

#### 2.04 CEILING EXHAUST AND RETURN REGISTERS/GRILLES

- A Manufacturers:
  - 1. Krueger-HVAC; 80: [www.krueger-hvac.com/#sle](http://www.krueger-hvac.com/#sle).
  - 2. Price Industries; 530
- B Type: Streamlined blades, 3/4 inch minimum depth, 3/4 inch maximum spacing, with blades set at 45 degrees, vertical face.
- C Frame: 1-1/4 inch margin with countersunk screw mounting.
- D Fabrication: Steel with 20 gauge, 0.0359 inch minimum frames and 22 gauge, 0.0299 inch minimum blades, steel and aluminum with 20 gauge, 0.0359 inch minimum frame, or aluminum extrusions, with factory baked enamel finish.
- E Color: white.

#### 2.05 HEAVY DUTY SUPPLY REGISTERS/GRILLES

- A Schedule Type Mark E Supply : Streamlined and individually adjustable blades, 3/4 inch minimum depth, 3/4 inch maximum spacing with spring or other device to set blades, vertical face, double deflection.
- B Schedule Type Mark 7 - Return: Streamlined and individually adjustable curved blades to discharge air along face of grille with one-way deflection.
- C Frame: 1-1/4 inch margin with countersunk screw mounting and gasket.
- D Fabrication: Steel with 14 ga steel minimum frames and 18 gauge minimum blades, with factory baked enamel finish.
- E Color: To be selected by Architect from manufacturer's standard range.
- F Gymnasiums: Provide front pivoted or welded in place blades, securely fastened to be immobile.
- G General Requirements:
  - 1. Diffuser material to comply with ASTM E84, UL 723, UL 2518, NFPA 90A, and NFPA 90B.
  - 2. Air Dispersion Method:
  - 3. Hanger Supports:

#### 2.06 LOUVERS

- A Manufacturers:
  - 1. Ruskin Company; HZ700MD: [www.ruskin.com/#sle](http://www.ruskin.com/#sle). AMCA540/550 Extreme Performace and AMCA 500-L wind driven rain Miami-Dade listed louver.
- B Type: Double frane 4 inch deep front frame and 3 inch deep rear framefor combined frame depth of 7 inches, with horizontal front blade on a 3.8 inch center to center spacing and vertical rear blade on a 3/4 inc center to center spacing.,1/2 inch square mesh screen over exhaust end.
- C Fabrication: 6063T6 extruded aluminum with .080" and .050" nominal wall thickness thick galvanized aluminum welded assembly, with factory prime coat finish.

### PART 3 EXECUTION

#### 3.01 INSTALLATION

- A Install in accordance with manufacturer's instructions.
- B Check location of outlets and inlets and make necessary adjustments in position to comply with architectural features, symmetry, and lighting arrangement.
- C Install diffusers to ductwork with air tight connection.
- D Provide balancing dampers on duct take-off to diffusers and grilles and registers, despite whether dampers are specified as part of diffuser, or grille and register assembly.
- E Paint ductwork visible behind air outlets and inlets matte black, see Section 09 91 23.

#### 3.02 PROTECTION

- A Protect installed products until completion of project.

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B Replace, repair, or touch-up damaged products before Substantial Completion.

**END OF SECTION 23 37 00**

**SECTION 23 74 00**  
**HIGH PERCENTAGE OUTSIDE AIR PACKAGED DX UNIT**

**PART 1 GENERAL**

**1.01 GENERAL DESCRIPTION**

- A This section includes the design, controls and installation requirements for packaged rooftop units / outdoor air handling units.

**1.02 REFERENCE STANDARDS**

- A AHRI Standard 920 (I-P) 2015 - Standard for Performance Rating of DX - Dedicated Outdoor Air System Units

**1.03 QUALITY ASSURANCE**

- A Packaged air-cooled condenser units shall be certified in accordance with ANSI/AHRI Standard 340/360 performance rating of commercial and industrial unitary air-conditioning and heat pump equipment.
- B Packaged air-cooled condenser units shall be certified in accordance with AHRI Standard 920 performance rating of DX Dedicated Outdoor Air System Units.
- C Unit shall be certified in accordance with UL Standard 1995/CSA C22.2 No. 236, Safety Standard for Heating and Cooling Equipment.
- D Unit and refrigeration system shall comply with ASHRAE 15, Safety Standard for Mechanical Refrigeration.
- E Unit Energy Efficiency Ratio (EER) shall be equal to or greater that prescribed by ASHRAE 90.1, Energy Efficient Design of New Buildings except Low-Rise Residential Buildings.
- F Unit shall be safety certified by ETL and ETL US listed. Unit nameplate shall include the ETL/ETL Canada label.

**1.04 SUBMITTALS**

- A Product Data: Literature shall be provided that indicates dimensions, operating and shipping weights, capacities, ratings, fan performance, filter information, factory supplied accessories, electrical characteristics and connection requirements. Installation, Operation, and Maintenance manual with startup requirements shall be provided.
- B Shop Drawings: Unit drawings shall be provided that indicate assembly, unit dimensions, construction details, clearances and connection details. Computer generated fan curves for each fan shall be submitted with specific design operation point noted. Wiring diagram shall be provided with details for both power and control systems and differentiate between factory installed and field installed wiring.

**1.05 COORDINATION**

- A If equipment is supplied by a manufacturer other than the one named, coordinate with the General Contractor and affected subcontractors to ensure the specified performance is met. This coordination shall include (but is not limited to) the following:
  1. Structural supports for units.
  2. Size and location of concrete bases/housekeeping pads
  3. Location of roof curbs, unit supports and roof penetrations
  4. Ductwork sizes and connection locations
  5. Piping size and connection/header locations
  6. Interference with existing or planned ductwork, piping and wiring
  7. Electrical power requirements and wire/conduit and over current protection sizes.
  8. Trap height requirements
- B The Mechanical Contractor shall be responsible for costs incurred by the General Contractor, Subcontractors, and Consulting Engineers to accommodate units furnished by a manufacturer other than manufacturer named as basis of design.

**1.06 DELIVERY, STORAGE, AND HANDLING**

- A Unit shall be shipped with doors screwed shut and outside air hood closed to prevent damage during transport and thereafter while in storage awaiting installation.
- B Follow Installation, Operation, and Maintenance manual instructions for rigging, moving, and unloading the unit at its final location.
- C Unit shall be stored in a clean, dry place protected from construction traffic in accordance with the Installation, Operation, and Maintenance manual.

**1.07 WARRANTY**

- A Manufacturer shall provide a limited “parts only” warranty for a period of 12 months from the date of equipment startup or 18 months from the date of original equipment shipment from the factory, whichever is less. Warranty shall cover material and workmanship that prove defective, within the specified warranty period, provided manufacturer’s written instructions for Installation, Operation, and maintenance have been followed. Warranty excludes parts associated with routine maintenance, such as belts and filters.

**PART 2 PRODUCTS**

**2.01 MANUFACTURERS:**

- A AAON
- B Addison
- C Captive-Aire
- D Desert Aire
- E Greenheck
- F Johnson
- G Trane
- H Tempmaster
- I Or Approved Equal
- J Substitute equipment may be considered for approval that includes at a minimum:
  - 1. R-410A refrigerant
  - 2. Variable capacity compressor with 15-100% capacity control
  - 3. Direct drive supply fans
  - 4. Double wall cabinet construction
  - 5. Insulation with a minimum R-value of 13.0
  - 6. Stainless steel drain pans

**2.02 ROOFTOP UNITS**

- A General Description
  - 1. Packaged rooftop unit shall include compressors, evaporator coils, filters, supply fans, dampers, air-cooled condenser coils, condenser fans, reheat coil, exhaust fans, and unit controls.
  - 2. Unit shall be factory assembled and tested including leak testing of the DX coils, pressure testing of the refrigeration circuit, and run testing of the completed unit. Run test report shall be supplied with the unit in the service compartment’s literature pocket.
  - 3. Unit shall have decals and tags to indicate lifting and rigging, service areas and caution areas for safety and to assist service personnel.
  - 4. Unit components shall be labeled, including refrigeration system components and electrical and controls components.
  - 5. Estimated sound power levels (dB) shall be shown on the unit ratings sheet.
  - 6. Installation, Operation, and Maintenance manual shall be supplied within the unit.
  - 7. Laminated color-coded wiring diagram shall match factory installed wiring and shall be affixed to the interior of the control compartment’s hinged access door.
  - 8. Unit nameplate shall be provided in two locations on the unit, affixed to the exterior of the unit and affixed to the interior of the control compartment’s hinged access door.
- B Performance
  - 1. Refer to Schedule on Drawings for equipment capacities, ambient conditions, etc.
  - 2. Unit performance shall be rated in accordance with AHRI 920. Manufacturer shall provide the Integrated Seasonal Moisture Removal Efficiency (ISMRE). Efficiency shall comply with ASHRAE 90.1-2016.
- C Construction
  - 1. All cabinet walls, access doors, and roof shall be fabricated of double wall, impact resistant, rigid polyurethane foam panels.
  - 2. Unit insulation shall have a minimum thermal resistance R-value of 13. Foam insulation shall have a minimum density of 2 pounds/cubic foot and shall be tested in accordance with ASTM D1929-11.

3. Unit construction shall be double wall with G90 galvanized steel on both sides and a thermal break. Double wall construction with a thermal break prevents moisture accumulation on the insulation, provides a cleanable interior, prevents heat transfer through the panel, and prevents exterior condensation on the panel.
  4. Unit shall be designed to reduce air leakage and infiltration through the cabinet. Cabinet leakage shall not exceed 1% of total airflow when tested at 3 times the minimum external static pressure provided in AHRI Standard 340/360. Panel deflection shall not exceed L/240 ratio at 125% of design static pressure, at a maximum 8 inches of positive or negative static pressure, to reduce air leakage. Deflection shall be measured at the midpoint of the panel height and width. Continuous sealing shall be included between panels and between access doors and openings to reduce air leakage. Piping and electrical conduit through cabinet panels shall include sealing to reduce air leakage.
  5. Roof of the air tunnel shall be sloped to provide complete drainage. Cabinet shall have rain break overhangs above access doors.
  6. Access to filters, dampers, cooling coils, reheat coil, exhaust fans, energy recovery wheels, compressors, and electrical and controls components shall be through hinged access doors with quarter turn, zinc cast, lockable handles. Full length stainless steel piano hinges shall be included on the doors.
  7. Exterior paint finish shall be capable of withstanding at least 2,500 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B 117-95 test procedure.
  8. Units with cooling coils shall include double sloped 304 stainless steel drain pans.
  9. Unit shall be provided with horizontal discharge and return air openings. All openings through the base pan of the unit shall have upturned flanges of at least 1/2 inch in height around the opening.
  10. Unit shall include lifting lugs on the top of the unit.
- D Electrical
1. Unit shall be provided with factory installed and factory wired, non-fused disconnect switch.
  2. Unit shall be provided with a factory installed and factory wired 115V, 12 amp GFI outlet disconnect switch in the unit control panel.
  3. Unit shall be provided with phase and brown out protection which shuts down all motors in the unit if the electrical phases are more than 10% out of balance on voltage, the voltage is more than 10% under design voltage or on phase reversal.
- E Motorized Dampers
1. Frame shall be constructed of a 16 gage galvanized steel hat-channel.
  2. Blades shall be constructed of 16 gage galvanized steel strengthened by three longitudinal 1 inch deep "vee" grooves.
  3. Blades shall be symmetrical relative to its axle pivot point.
  4. Axle bearings shall be synthetic sleeve-type and rotate inside extruded holes in the damper frame.
  5. Blade seals shall be extruded vinyl permanently bonded to the appropriate blade edges.
  6. Frame shall include flexible stainless steel compression-type jamb seals.
  7. Modulating spring-return actuators shall be provided by the factory, installed on the damper, and wired to the control center. Each damper shall have a dedicated actuator. Single actuators with gear trains are not acceptable.
  8. Damper leakage shall be no more than 3 cfm/sq.ft. at 1 in.wg static pressure.
- F Supply Fans (VFD)
1. Unit shall include direct drive, unhooded, backward curved, plenum supply fans.
  2. Blowers and motors shall be dynamically balance and mounted on rubber isolators.
  3. Motors shall be premium efficiency ODP with ball bearings rated for 200,000 hours service with external lubrication points.
  4. Variable frequency drives shall be factory wired and mounted in the unit. Fan motors shall be premium efficiency.
  5. Fan wheel shall be tested in accordance to AMCA 210.
- G Exhaust Fans (VFD)
1. Exhaust dampers shall be sized for 100% relief.

2. Fans and motors shall be dynamically balanced.
  3. Motors shall be premium efficiency ODP with ball bearings rated for 200,000 hours service with external lubrication points.
  4. Access to exhaust fans shall be through double wall, hinged access doors with quarter turn lockable handles.
  5. Unit shall include direct drive or belt driven, unhooded, backward curved, plenum exhaust fans.
  6. Variable frequency drives shall be factory wired and mounted in the unit. Fan motors shall be premium efficiency.
- H Total Enthalpy Wheel - Silica Gel Dessicant
1. Energy recovery shall be an integral part of unit from the manufacturer. No field assembly, ducting, or wiring shall be required with the energy recovery option.
  2. Energy recovery media shall be accessible through a 2" thick, foam-injected, double-wall, hinged access door with quarter-turn latches.
  3. Energy recovery shall be provided through a total enthalpy wheel providing sensible and latent energy transfer per the scheduled performance.
  4. Energy recovery wheel shall be constructed of lightweight polymer substrate with permanently-bonded silica gel desiccant.
  5. Energy recovery wheel cassette shall be mounted perpendicular (90°) to the base of the unit.
  6. A VFD shall be required to modulate the speed of the wheel and to provide soft start to extend the life of the belt.
  7. Individual pie-shaped wheel sections shall be removable from wheel cassette for maintenance.
  8. Wheel bearings shall be selected to provide an L-10 life in excess of 400,000 hours.
  9. Rim shall be continuous rolled stainless steel and the wheel shall be connected to the shaft by means of taper locks.
  10. Energy wheel cassette shall include seals, drive motor, and urethane drive belt.
  11. Latent energy shall be transferred entirely in the vapor phase with no condensation.
  12. The energy recovery cassette and wheel drive motor shall be an Underwriters Laboratories Recognized Component for electrical and fire safety.
  13. Thermal performance shall be certified by the wheel manufacturer in accordance with ASHRAE Standard 84, Method of Testing Air-to-Air Heat Exchangers and AHRI Standard 1060, Rating Air-to-Air Energy Recovery Ventilation Equipment.
- I Cooling Coils
1. DX Evaporator Coils
    - a. Coil shall be rated in accordance to AHRI standards, designed to withstand 250 psig working pressure at 300 degrees F, and pressure tested to 600 psig.
    - b. Coils shall be designed for use with R-410A refrigerant and constructed of copper tubes with aluminum fins mechanically bonded to the tubes and galvanized steel end casings. Fin design shall be sine wave rippled.
    - c. Coils shall have interlaced circuitry and shall be standard capacity.
    - d. Coils shall have interlaced circuitry and shall be minimum 6 row high capacity.
    - e. Coils shall be hydrogen or helium leak tested.
    - f. Coils shall be furnished with factory installed expansion valves.
    - g. Cooling coils shall include corrosion-resistant, electrostatically-applied coating rated for 5,000 hours in accordance with ASTM B117.
- J Gas Heating:
1. Unit shall be provided with AGA-certified, induced-draft, 3:1 or 6:1 or 5:1 or 10:1 turndown indirect gas furnace. Unit shall be provided with AGA-certified, induced-draft, 10:1 turndown indirect gas furnace.
  2. Furnace assembly shall include the following items:
    - a. Electronic modulating gas valve.
    - b. Two-speed combustion fan.
    - c. Stainless steel heat exchanger.



K Hot Gas Reheat Coil

1. Hot-gas reheat coil shall be separated from the evaporator coil by a minimum of 6" in the direction of airflow to prevent the re-evaporation of condensate, provide room for coil cleaning, and allow control system to monitor evaporator coil leaving dew point temperature.
2. Coil shall be rated in accordance to AHRI standards, designed to withstand 250 psig working pressure at 300 degrees F, and pressure tested to 600 psig.
3. Coil casing shall be constructed of 16 gage galvanized steel or 304 stainless steel.
4. Coil tubes shall be constructed of 5/16" diameter, 0.012" thick seamless copper tubing.
5. Coil fins shall be constructed of 0.0060" thick aluminum fins.
6. Hot-gas reheat shall be controlled through a factory-supplied and controlled modulating 3-way valve.
7. Coil shall be hydrogen or helium leak tested.
8. Hot-gas reheat coil shall include corrosion-resistant, electrostatically-applied coating rated for 5,000 hours in accordance with ASTM B117.

L Refrigeration System

1. Unit shall be factory charged with R-410A refrigerant.
2. Compressors shall be scroll type with thermal overload protection and carry a 5 year non-prorated warranty, from the date of original equipment shipment from the factory.
3. Compressors shall be mounted in an isolated service compartment which can be accessed without affecting unit operation. Lockable hinged compressor access doors shall be fabricated of double wall, rigid polyurethane foam injected panels to prevent the transmission of noise outside the cabinet.
4. Compressors shall be isolated from the base pan with the compressor manufacturer's recommended rubber vibration isolators, to reduce any transmission of noise from the compressors into the building area.
5. Each refrigeration circuit shall be equipped with expansion valve type refrigerant flow control.
6. Each refrigeration circuit shall be equipped with automatic reset low pressure and manual reset high pressure refrigerant safety controls, Schrader type service fittings on both the high pressure and low pressure sides and a factory installed replaceable core liquid line filter driers.
7. Unit shall include a variable capacity scroll compressor on the lead refrigeration circuit which shall be capable of modulation from 10-100% of its capacity.
8. Lead refrigeration circuit shall be provided with hot gas reheat coil, modulating valves, electronic controller, supply air temperature sensor and a control signal terminal which allow the unit to have a dehumidification mode of operation, which includes supply air temperature control to prevent supply air temperature swings and overcooling of the space.
9. Unit shall be configured as an air-source heat pump. Each refrigeration circuit shall be equipped with a factory installed liquid line filter drier with check valve, reversing valve, accumulator, and expansion valves on both the indoor and outdoor coils. Reversing valve shall energize during the heat pump cooling mode of operation.

M Condensers

1. Air-Cooled Condenser
  - a. Condenser fans shall be a vertical discharge, axial flow, direct drive fans.
  - b. Coils shall be designed for use with R-410A refrigerant. Coils shall be multi-pass and fabricated from aluminum microchannel tubes.
  - c. Heat pump outdoor coil shall be constructed of copper tubes with aluminum fins mechanically bonded to the tubes and aluminum end casings. Fin design shall be sine wave rippled.
  - d. Coils shall be designed for a minimum of 10°F of refrigerant sub-cooling.
  - e. Coils shall be hydrogen or helium leak tested.
  - f. Condenser coils shall include corrosion-resistant, electrostatically-applied coating rated for 5,000 hours in accordance with ASTM B117.
  - g. Condenser fans shall be high efficiency electrically commutated motor driven with factory installed head pressure control module. Condenser airflow shall continuously modulate based on head pressure and cooling operation shall be allowed down to 35°F with adjustable compressor lockout.

- h. Condenser fans shall be VFD driven variable speed for condenser head pressure control. Factory provided and factory programmed VFDs shall continuously modulate the fan air flow to maintain head pressure at acceptable levels. Cooling operation shall be allowed down to 35°F with adjustable compressor lockouts.
- N Filters
  - 1. Outdoor air hood shall have a aluminum mesh filter section.
  - 2. Unit shall include 2 inch thick, pleated panel filters with an ASHRAE efficiency of 30% and MERV rating of 13, upstream of the cooling coil.
  - 3. Unit shall include 0-100% economizer consisting of a motor operated outside air damper and return air damper assembly constructed of extruded aluminum, hollow core, airfoil blades with rubber edge seals and aluminum end seals. Damper blades shall be gear driven and designed to have no more than 20 cfm of leakage per sq ft. at 4 in. w.g. air pressure differential across the damper. Low leakage dampers shall be Class 2 AMCA certified, in accordance with AMCA Standard 511. Damper assembly shall be controlled by spring return enthalpy activated fully modulating actuator. Unit shall include outside air opening bird screen, outside air hood, and barometric relief dampers.
  - 4. Economizer shall be furnished with return air CO2 override.
- O Controls
  - 1. Factory Installed Controller
    - a. The unit shall come with a factory programmed and supplied controller that provide all programming and functionality for the unit to operate, including internal safeties.
    - b. All sensors required for the operation of the unit shall be factory furnished. This includes outside air temperature and humidity sensors, supply air temperature and humidity sensors, coil suction pressure and temperature sensors, space temperature and humidity sensors, preheat discharge temperature sensor, and other sensors as required to implement the sequence of operations. Refer to sequence on Drawings.
- P Accessories
  - 1. Unit shall be provided with a smoke detector in the supply of the unit, wired to shut off the unit's control circuit.

### 2.03 CURBS

- A Curbs shall to be fully gasketed between the curb top and unit bottom with the curb providing full perimeter support, cross structure support and air seal for the unit. Curb gasket shall be furnished within the control compartment of the rooftop unit to be mounted on the curb immediately before mounting of the rooftop unit.
- B Height of curb shall be at least the minimum required to accommodate the horizontal discharge openings.
- C Solid bottom curb shall be factory assembled and fully lined with 1 inch neoprene coated fiberglass insulation and include a wood nailer strip. Curb shall be adjustable up to 3/4 inch per foot to allow for sloped roof applications.
- D Curb shall be rated for the project wind zone.

## PART 3 EXECUTION

### 3.01 INSTALLATION, OPERATION, AND MAINTENANCE

- A Installation, Operation, and Maintenance manual shall be supplied with the unit.
- B Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- C Examine casing insulation materials and filter media before air-to-air energy recovery equipment installation. Reject insulation materials and filter media that do not comply, or are wet, moisture damaged, or mold damaged.
- D Install units with clearances for service and maintenance.
- E Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- F Installing contractor shall install unit, including field installed components, in accordance with Installation, Operation, and Maintenance manual instructions.
- G Start up and maintenance requirements shall be complied with to ensure safe and correct operation of the unit.

**3.02 OWNER TRAINING**

- A Location: Job site
- B An authorized manufacturer's representative shall conduct the training session.
- C Provide minimum four (4) hours training for six (6) people.
- D Provide video recording of the training session. Turn over video to Owner at the conclusion of the project.

**END OF SECTION 23 74 00**

**SECTION 23 81 19**  
**SELF-CONTAINED AIR-CONDITIONERS**

**<<<< UPDATE NOTES**

**PART 1 GENERAL**

**2.01 SECTION INCLUDES**

- A Packaged terminal heat pump units.
- B Wall sleeves.
- C Louvers.
- D Controls.

**2.02 RELATED REQUIREMENTS**

- A Section 26 05 83 - Wiring Connections: Installation of thermostats and other control components.
- B Section 26 05 83 - Wiring Connections: Electrical characteristics and wiring connections.

**2.03 REFERENCE STANDARDS**

- A AHRI 210/240 - Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment; 2023.

**2.04 SUBMITTALS**

- A See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B Product Data: Provide drawings indicating dimensions, rough-in connections, and electrical characteristics and connection requirements.
- C Manufacturer's Instructions: Include assembly instructions, support details, connection requirements, and start-up instructions.
- D Operation and Maintenance Data: Provide maintenance data, parts lists, controls, and accessories. Include trouble-shooting guide.
- E Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

**2.05 WARRANTY**

- A See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B Provide a five year warranty to include coverage for refrigeration compressors.

**PART 2 PRODUCTS**

**3.01 MANUFACTURERS**

**3.02 AIR CONDITIONING UNITS**

- A Description: Packaged, self-contained, through-the-wall air cooled terminal air conditioning units, with wall sleeve, room cabinet, electric refrigeration system, electric heating, outside air louvers, built-in temperature controls; fully charged with refrigerant and filled with oil.
- B Electrical Characteristics:
- C Energy Efficiency:

**3.03 CABINET**

- A Cabinet: Wall mounted of 18 gauge, 0.0478 inch galvanized steel with epoxy coated finish, removable front panel with concealed latches, color as selected.
- B Discharge Grille and Access Door: Removable punched louver discharge grilles, allowing 4-way discharge air pattern with hinged door in top of cabinet for access to controls.

**3.04 WALL SLEEVES AND LOUVERS**

- A Wall Sleeves: 16 inches deep, 16 gauge, 0.0598 inch galvanized steel with protective mastic coating.
- B Louvers: Provide flush anodized aluminum with enamel finish, color as selected.

**3.05 CHASSIS**

- A Refrigeration System:
  - 1. Direct expansion cooling coil.
  - 2. Hermetically sealed compressor with internal spring isolation, external isolation, permanent split capacitor motor and overload protection.
  - 3. Accumulator.
- B Air System: Centrifugal forward curved tangential evaporator fans with two speed permanent split capacitor motor, permanent washable filters, positive pressure ventilation damper with concealed manual operator.

- C Condensate Drain: Drain pan to direct condensate to condenser coil for re-evaporation.

**3.06 CONTROLS**

- A Control Module: Unit mounted adjustable thermostat with heat anticipator, heat-off-cool switch, high-low fan switch.

**PART 3 EXECUTION**

**4.01 INSTALLATION**

- A Install in accordance with manufacturer's instructions.
- B Coordinate installation of units with architectural, mechanical, and electrical work.

**END OF SECTION 23 81 19**

**SECTION 23 81 26.13**  
**SMALL-CAPACITY SPLIT-SYSTEM AIR CONDITIONERS**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A Air cooled condensing units.
- B Indoor air handling (fan and coil) units for ductless systems.
- C Controls.

**1.02 RELATED REQUIREMENTS**

- A Section 26 05 83 - Wiring Connections: Electrical characteristics and wiring connections and installation and wiring of thermostats and other controls components.

**1.03 REFERENCE STANDARDS**

- A AHRI 210/240 - Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment; 2023.
- B AHRI 520 - Performance Rating of Positive Displacement Condensing Units; 2004.
- C ASHRAE Std 15 - Safety Standard for Refrigeration Systems; 2019, with All Amendments and Errata.
- D ASHRAE Std 23 - Methods for Performance Testing Positive Displacement Refrigerant Compressors and Compressor Units; 2022.
- E NEMA MG 1 - Motors and Generators; 2018.
- F NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2021.
- G NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems; 2021.
- H UL 207 - Standard for Refrigerant-Containing Components and Accessories, Nonelectrical; Current Edition, Including All Revisions.

**1.04 SUBMITTALS**

- A See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B Product Data: Provide rated capacities, weights, accessories, electrical nameplate data, and wiring diagrams.
- C Design Data: Indicate refrigerant pipe sizing.
- D Manufacturer's Instructions: Indicate rigging, assembly, and installation instructions.
- E Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listing.
- F Warranty: Submit manufacturers warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.
- G Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
  - 1. See Section 01 60 00 - Product Requirements, for additional provisions.
  - 2. Extra Filters: One for each unit.

**1.05 WARRANTY**

- A See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B Provide three year manufacturers warranty for solid state ignition modules.

**PART 2 PRODUCTS**

**2.01 SYSTEM DESIGN**

- A Ductless Split-System Heating and Cooling Units: Self-contained, packaged, matched factory-engineered and assembled, pre-wired indoor and outdoor units; UL listed.
  - 1. Heating: None.
  - 2. Cooling: Outdoor electric condensing unit with evaporator coil in central ducted indoor unit.
  - 3. Provide refrigerant lines internal to units and between indoor and outdoor units, factory cleaned, dried, pressurized and sealed, with insulated suction line.
- B Performance Requirements: See Drawings for additional requirements.
- C Electrical Characteristics:
  - 1. Disconnect Switch: Factory mount disconnect switch on equipment under provisions of Section 26 05 83.

**2.02 INDOOR AIR HANDLING UNITS FOR DUCTLESS SYSTEMS**

- A Manufacturers:
  - 1. Mitsubishi; MSY:

- B Indoor Units: Self-contained, packaged, factory assembled, pre-wired unit consisting of cabinet, supply fan, evaporator coil, and controls; wired for single power connection with control transformer.
  - 1. Location: High-wall.
  - 2. Cabinet: Galvanized steel.
    - a. Finish: White.
  - 3. Fan: Line-flow fan direct driven by a single motor.
- C Evaporator Coils: Copper tube aluminum fin assembly, galvanized or polymer drain pan sloped in all directions to drain, drain connection, refrigerant piping connections, restricted distributor or thermostatic expansion valve.
  - 1. Construction and Ratings: In accordance with AHRI 210/240 and UL 207.
  - 2. Provide Epoxy coating for seacoast protection.
  - 3. Manufacturer: System manufacturer.

### 2.03 OUTDOOR UNITS

- A Outdoor Units: Self-contained, packaged, pre-wired unit consisting of cabinet, with compressor and condenser.
  - 1. Comply with AHRI 210/240.
  - 2. Refrigerant: Use only refrigerants that have ozone depletion potential (ODP) of zero and global warming potential (GWP) of less than 50.
  - 3. Cabinet: Galvanized steel with baked enamel finish, easily removed and secured access doors with safety interlock switches, glass fiber insulation with reflective liner.
  - 4. Construction and Ratings: In accordance with AHRI 210/240 with testing in accordance with ASHRAE Std 23 and UL 207.
- B Compressor: Hermetic, two speed 1800 and 3600 rpm, AHRI 520 resiliently mounted integral with condenser, with positive lubrication, crankcase heater, high-pressure control, motor overload protection, service valves and drier. Provide time delay control to prevent short cycling and rapid speed changes.
- C Air Cooled Condenser: Aluminum fin and copper tube coil, AHRI 520 with direct drive axial propeller fan resiliently mounted, galvanized fan guard. Provide epoxy coating for seacoast protection.
- D Accessories: Filter drier, high-pressure switch (manual reset), low pressure switch (automatic reset), service valves and gauge ports, thermometer well (in liquid line).
  - 1. Provide thermostatic expansion valves.
- E Operating Controls:
  - 1. Control by room thermostat to maintain room temperature setting.
- F Mounting Pad: Precast concrete parking bumpers, minimum 4 inches square; minimum of two located under cabinet feet.

### 2.04 ACCESSORY EQUIPMENT

- A Room Thermostat: Wall-mounted, electric solid state microcomputer based room thermostat with remote sensor to maintain temperature setting; low-voltage; with following features:
  - 1. Automatic switching from heating to cooling.
  - 2. Preferential rate control to minimize overshoot and deviation from setpoint.
  - 3. Thermostat Display:
    - a. Actual room temperature.
    - b. System Mode Indication: Heating, Cooling, Fan Auto, Off, and On, Auto or On, Off.

## PART 3 EXECUTION

### 3.01 EXAMINATION

- A Verify that substrates are ready for installation of units and openings are as indicated on shop drawings.
- B Verify that proper power supply is available and in correct location.
- C Verify that proper fuel supply is available for connection.

### 3.02 INSTALLATION

- A Install in accordance with NFPA 90A and NFPA 90B.
- B Install refrigeration systems in accordance with ASHRAE Std 15.

**END OF SECTION 23 81 26.13**

**SECTION 23 82 00**  
**CONVECTION HEATING AND COOLING UNITS**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A Electric unit heaters.
- B Blower-coil units.

**1.02 RELATED REQUIREMENTS**

- A Section 03 30 00 - Cast-in-Place Concrete.
- B Section 23 05 13 - Common Motor Requirements for HVAC Equipment.
- C Section 23 07 19 - HVAC Piping Insulation.
- D Section 23 09 13 - Instrumentation and Control Devices for HVAC.
- E Section 23 09 93 - Sequence of Operations for HVAC Controls.
- F Section 23 21 13 - Hydronic Piping.
- G Section 23 21 14 - Hydronic Specialties.
- H Section 23 23 00 - Refrigerant Piping.
- I Section 23 31 00 - HVAC Ducts and Casings.

**1.03 REFERENCE STANDARDS**

- A AHRI Directory of Certified Product Performance - Air-Conditioning, Heating, and Refrigeration Institute (AHRI); Current Edition.
- B AHRI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils; 2001, with Addenda (2011).
- C NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2021.
- D SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2021.

**1.04 SUBMITTALS**

- A See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B Product Data: Provide typical catalog of information including arrangements.
- C Shop Drawings:
  - 1. Indicate cross sections of cabinets, grilles, bracing and reinforcing, and typical elevations.
  - 2. Indicate air coil and frame configurations, dimensions, materials, rows, connections, and rough-in dimensions.
  - 3. Submit schedules of equipment and enclosures typically indicating length and number of pieces of element and enclosure, corner pieces, end caps, cap strips, access doors, pilaster covers, and comparison of specified heat required to actual heat output provided.
  - 4. Submit the following for blower-coil units indicating:
    - a. Overall dimensions including installation, operation, and service clearances.
    - b. Lift points, recommendations, and center of gravity.
    - c. Unit shipping, installation, and operating weights including dimensions.
    - d. Fan curves with specified operating point clearly plotted.
    - e. Safety and start-up instructions.
- D Manufacturer's Instructions: Indicate installation instructions and recommendations.
- E Project Record Documents: Record actual locations of components and locations of access doors in radiation cabinets required for access or valving.
- F Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listings.
- G Warranty: Submit manufacturer's warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

**1.05 QUALITY ASSURANCE**

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

**1.06 WARRANTY**

- A See Section 01 78 00 - Closeout Submittals for additional warranty requirements.



**PART 2 PRODUCTS**

**2.01 ELECTRIC UNIT HEATERS**

- A Provide products listed, classified, and labeled by Underwriters Laboratories Inc. (UL), Intertek (ETL), or testing firm acceptable to authority having jurisdiction as suitable for purpose indicated.
- B Heating Element Assembly:
  - 1. Thermal safety cut-out within electric terminal box with automatically reset switch located near electric terminal box.
- C Housing:
  - 1. Suitable for ceiling or high altitude mount using provided hardware appendages.
- D Air Inlets and Outlets:
  - 1. Inlets: Provide stamped louvers or protective grilles with fan blade guard.
  - 2. Outlets: Provide diffuser cones, directional louvers, or radial diffusers.
- E Fan: Factory balanced, direct drive, axial type with fan guard.
- F Motor: Totally enclosed, thermally protected, and provided with permanently lubricated bearings.
- G Controls:
- H Electrical Characteristics:

**2.02 BLOWER-COIL UNITS**

- A Manufacturers:
  - 1. Carrier Corporation; \_\_\_\_\_: [www.commercial.carrier.com/#sle](http://www.commercial.carrier.com/#sle).
  - 2. Johnson Controls International, PLC; \_\_\_\_\_: [www.johnsoncontrols.com/#sle](http://www.johnsoncontrols.com/#sle).
  - 3. Krueger-HVAC; \_\_\_\_\_: [www.krueger-hvac.com/#sle](http://www.krueger-hvac.com/#sle).
  - 4. Trane Technologies, PLC; \_\_\_\_\_: [www.trane.com/#sle](http://www.trane.com/#sle).
- B Performance Data and Safety Requirements:
  - 1. Coils rated and tested in accordance with AHRI 410.
  - 2. Provide products listed, classified, and labeled by Underwriters Laboratories Inc. (UL), Intertek (ETL), or testing firm acceptable to authority having jurisdiction as suitable for purpose indicated.
  - 3. Comply with NFPA 90A for unit construction, including filters and related equipment, for protection of life and property from fire, smoke, and gases resulting from conditions having manifestations similar to fire.
- C Unit Casing:
  - 1. Fabricate from heavy gauge galvanized steel sheet.
  - 2. Insulate inside walls with 1 inch thick, fiberglass insulation for thermal and acoustical control.
  - 3. Provide access panels allowing servicing of coils, drain pan, fan, motor, and drive.
  - 4. Provide knockouts or hanger rod holes at all four corners for suspended units.
- D Air Coils:
  - 1. Aluminum fins mechanically expanded or bonded to copper tubes having standard sweat connections.
    - a. Water: Manual, automatic or self-venting, designed to a working pressure and temperature of not less than 250 psig and 200 degrees F.
    - b. Direct Expansion (DX): Thermal expansion valve and distributor, dehydrated, sealed with dry charge, and factory proof tested for leaks.
    - c. Provide Epoxy coating for seacoast protection
- E Fans: Forward curved, centrifugal blower, dynamically balanced, adjustable speed V-belt drive with fan shaft supported by heavy-duty, permanently sealed ball bearings.
- F Drain Pan: Cleanable, one-piece construction of polymer, galvanized steel, or stainless steel; with drain connection and sloped for positive drainage.
- G Filters: Fully accessible, flat filter rack with throw-away filters.
- H Motors: Single speed with sleeve or ball bearings, 1,750 rpm, wired to unit junction box, and mounted on a resilient motor base.
- I Mixing Box: Factory assembled fresh air and return air dampers including linkage and ready for field installation of damper actuator.
- J Electrical Controls:
- K Electrical Characteristics:

**PART 3 EXECUTION**

**3.01 EXAMINATION**

- A Verify that surfaces are suitable for installation.
- B Verify that field measurements are as indicated on drawings.

**3.02 PREPARATION**

- A Provide housekeeping pads for blower-coil units under provisions of Section 03 30 00.

**3.03 INSTALLATION**

- A Install in accordance with manufacturer's recommendations.
- B Do not damage equipment or finishes.
- C Blower-Coil Units:
  1. Verify all surfaces and openings at unit location can suitably accommodate unit(s).
  2. Install in accordance with manufacturer's recommendations.
  3. Provide manual shut-off valve on hydronic supply side of coil and balancing valve with memory stop on return side.
  4. General piping installation requirements are specified in other Sections and drawings indicate general arrangement of piping, fittings, and specialties.
  5. Connect hydronic, condensate drain, and overflow drain piping to unit.

**3.04 CLEANING**

- A After construction and painting is completed, clean exposed surfaces of units.
- B Vacuum clean coils and inside of units.
- C Touch-up marred or scratched surfaces of factory-finished cabinets using finish materials furnished by the manufacturer.
- D Install new filters.

**3.05 CLOSEOUT ACTIVITIES**

- A See Section 01 78 00 - Closeout Submittals for closeout submittals.
- B See Section 01 79 00 - Demonstration and Training for additional requirements.

**END OF SECTION 23 82 00**

**SECTION 26 00 02**  
**ELECTRICAL PREFERRED ALTERNATES**

**PART 1 GENERAL**

**1.01 LIST OF ALTERNATES**

- A Refer to Architect's Division 01 Specification for Bid Alternates.

**END OF SECTION 26 00 02 26 00 02**

**SECTION 26 01 00**  
**ELECTRICAL GENERAL PROVISIONS**

**PART 1 GENERAL**

**1.01 SCOPE OF WORK**

- A This Contractor shall provide all materials, equipment and labor necessary to install and set into operation the electrical equipment as shown on the Engineering Drawings and as contained herein.

**1.02 QUALITY ASSURANCE**

- A See the General and Supplementary General Conditions and Architectural Divisions.
- B All work shall be in accordance with the North Carolina State Building Code, which includes the 2020 edition of the National Electrical Code.
- C The Contractor shall be responsible for obtaining all permits and shall notify inspection departments as work progresses.
- D Wherever the words "Approved", "Approval", and "Approved Equal" appear, it is intended that items other than the model numbers specified shall be subject to the approval of the Engineer.
- E "Provide" as used herein shall mean that the Contractor responsible shall furnish and install said item or equipment. "Furnish" as used herein shall mean that the Contractor responsible shall acquire and make available said item or equipment and that installation shall be by others. "Install" as used herein shall mean that the Contractor responsible shall make installation of items or equipment furnished by others.
- F All personnel under this Contractor's supervision shall be qualified to perform those portions of the work assigned to them. Personnel (including project managers) deemed to be negative to the overall success of the project shall be removed from the project and replaced with qualified personnel who will be positive for the project. Upon written notification that particular personnel have been deemed negative to the overall success of the project, this Contractor shall immediately replace such particular personnel. The engineer shall be sole arbiter and any decision regarding fitness of this Contractor's personnel for this project shall not be subject to appeal.

**1.03 SUBMITTALS**

- A See General and Supplementary General Conditions and Division 1.
- B Within ten (10) days after notification of the award of the Contract and written notice to begin work, the Contractor shall submit for approval to the Architect/Engineer a detailed list of equipment and material which he proposes to use.
- C The Contractor shall provide an electronic pdf copy of the submittal data on the products, methods, etc. proposed for use on the project. The submittal shall contain complete submittal data on all products, methods, etc. proposed for use on the project.
- D Each submittal shall bear the approval of the Contractor indicating that he has reviewed the data and found it to meet the requirements of the specifications as well as space limitations and other project conditions. The submittals shall be clearly identified showing project name, manufacturer's catalog number and all necessary performance and fabrication data. Detailed submittal data shall be provided when items are to be considered as substitution for specified items. Acceptance for approval shall be in writing from the Engineer.
- E The Contractor shall submit to the Engineer a set of accurately marked-up plans indicating all changes encountered during the construction. Final payment will be contingent on receipt of these as-built plans.
- F The Contractor shall furnish an electronic copy of maintenance and operating instructions.
- G The Contractor shall submit to the Engineer a duplicate set of final electrical inspection certificates prior to final payment.

**1.04 PRODUCT DELIVERY, STORAGE AND HANDLING**

- A All material and equipment shall be delivered and unloaded by the Contractor within the project site as noted herein or as directed by the Owner.
- B The Contractor shall protect all material and equipment from breakage, theft or weather damage. No material or equipment shall be stored on the ground.
- C The material and equipment shall remain the property of the Contractor until the project has been completed and turned over to the Owner.
- D Where equipment cannot be stored at the site due to exposure to the elements or lack of storage space, the contractor shall store all equipment in a bonded warehouse until the time of installation.

### 1.05 WORK CONDITIONS AND COORDINATION

- A The Contractor shall review the entire set of plans to establish points of connection and the extent of electrical work to be provided in his Contract.
- B The contractor is responsible for reviewing the complete set of contract documents. Coordinate all phasing requirements with architectural drawings. Coordinate equipment locations and utility routing with all trades to ensure code compliance and constructibility.
- C This Contractor shall be responsible for all electrical work and make final connections to equipment installed in his Contract.
- D Pipe, conduit and duct chases required for installation of work shall be provided by the General Contractor unless otherwise noted. This Contractor shall be responsible for coordinating the location of all required chases.
- E All work shall be coordinated with other trades. Cutting of new work and subsequent patching shall be approved by Architect/ Engineer and shall be at the Contractor's expense with no extra cost to the Owner.

### 1.06 GUARANTEE

- A See the General and Supplementary General Conditions.
- B Where extended warranties or guarantees are available from the manufacturer, the Contractor shall prepare the necessary Contract Documents to validate these warranties as required by the manufacturer and present them to the Architect/Engineer.

## PART 2 PRODUCTS

### 2.01 MATERIAL QUALITY

- A Material and equipment shall be new, unless noted otherwise, of the highest grade and quality and free from defects or other imperfections. Material and equipment found defective shall be removed and replaced at the Contractor's expense.

### 2.02 EQUIPMENT LISTINGS

- A All materials and equipment shall be third party listed by an agency accredited by the NCBCC and NC Department of Insurance (NC DOI). The list of accredited agencies may be obtained on NCDOT's web site.

## PART 3 EXECUTION

### 3.01 INSPECTION

- A If any part of this Contractor's work is dependent for its proper execution or for its subsequent efficiency or appearance on the character or conditions of contiguous work not executed by him, the Contractor shall examine and measure such contiguous work and report to the Architect or Engineer in writing any imperfection therein, or conditions that render it unsuitable for the reception of this work. Should the Contractor proceed without making such written report, he shall be held to have accepted such work and the existing conditions and he shall be responsible for any defects in this work consequent hereon and will not be relieved of the obligation of any guarantee because of any such imperfection or condition.
- B After the designer pre-final inspection and confirmation that the final punch list items have been completed. The contractor shall schedule a final electrical inspection with the local inspections office.

### 3.02 INSTALLATION

- A All work shall be performed in a manner indicating proficiency in the trade.
- B All conduit, pipes, ducts, etc., shall be either parallel to building walls or plumb where installed in a vertical position and shall be concealed when located in architecturally finished areas.
- C Any cutting or patching required for installation of this Contractor's work shall be kept to a minimum. Written approval shall be required by the Architect/Engineer if cutting of primary structure is involved.
- D All patching shall be done in such a manner as to restore the areas or surfaces to match existing finishes.
- E The Contractor shall lay-out and install his work in advance of pouring concrete floors or walls. He shall furnish and install all sleeves or openings through poured masonry floors or walls above grade required for passage of all conduits, pipes or duct installed by him. The Contractor shall furnish and install all inserts and hangers required to support his equipment.
- F The Contractor shall be responsible for removing all spray-on fireproofing overspray from all equipment, light fixtures, and all other materials provided as part of the electrical contract.

### 3.03 PERFORMANCE

- A The Contractor shall perform all excavation and backfill operations necessary for installation of his work.

- B Rock excavation shall be defined in the Supplementary General Conditions, Division 1 or Division 2. Unless specifically stated, neither rock excavation nor a unit price for rock excavation shall be required in the bid.

**3.04 ERECTION**

- A All support steel, angles, channels, pipes or structural steel stands and anchoring devices that may be required to rigidly support or anchor material and equipment shall be provided by this Contractor.

**3.05 FIELD QUALITY CONTROL**

- A The Contractor shall conform to the requirements of Division 3 for concrete testing.
- B The Contractor shall test his entire installation and shall furnish the labor and materials required for these tests. Tests shall be performed in accordance with the requirements of the particular section of the specifications and in accordance with the requirements of the State Ordinances and Codes, and the National Electrical Code. The Contractor shall notify the Architect or Engineer of his readiness for such test. A final inspection by the Electrical Inspector or Local Authority Having Jurisdiction is required, and an inspection certificate is required prior to authorization of final payment.
- C Testing required for compliance with the Contract shall be stated in subsequent sections.
- D All tests specified shall be completely documented indicating time of day, date, temperature and all other pertinent test information including the entity conducting the test.
- E All required documentation of readings required by each test shall be submitted to the Engineer prior to, and as one of the prerequisites for, final acceptance of the project.

**3.06 ADJUST AND CLEAN**

- A All equipment and installed materials shall be thoroughly clean and free of all dirt, oil, grit, grease, etc.
- B Factory painted equipment shall not be repainted unless damaged areas exist. These areas shall be touched up with a material suitable for the intended service. In no event shall nameplates be painted.
- C At a scheduled meeting, the Contractor shall instruct the Owner or the Owner's representative in the operation and maintenance of all equipment installed under his Contract (in the presence of the Engineer).

**3.07 MAINTENANCE AND OPERATING MANUAL**

- A The Contractor shall prepare an electronic submission of a manual describing the proper maintenance and system operation. This manual shall not consist of standard factory printed data intended for dimension or design purposes (although these may be included), but shall be prepared to describe this particular job. This manual shall include the following:
  - B Data on all equipment as listed on the fixture and equipment schedules on the plans. Also data on all fire alarm, VOIP/Data network system, public address system, security system, lighting control systems, I/P Camera system, battery backup system, Bi-Directional Amplification (BDA), etc. that are applicable for the project.
  - C Warranties as required for each product.
  - D A check list for periodic maintenance of all equipment requiring maintenance. (i.e., fire alarm system, security system, generator, battery backup system, etc.)
  - E Maintenance and spare parts data for all equipment.
  - F As-Built wiring for equipment containing field wired systems. (i.e., fire alarm, security, data system, camera, public address, etc.)
  - G The manuals shall be dated and signed by the Contractor when completed.
  - H The operating and maintenance manuals shall be submitted to the Engineer for approval. When the manuals are considered complete by the Engineer, they will be turned over to the Owner for their permanent use.

**END OF SECTION 26 01 00 26 01 00**

**SECTION 26 05 05**  
**ELECTRICAL DEMOLITION**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A Electrical demolition.

**PART 2 PRODUCTS**

**2.01 MATERIALS AND EQUIPMENT**

- A Materials and equipment for patching and extending work.

**PART 3 EXECUTION**

**3.01 EXAMINATION**

- A Verify field measurements and circuiting arrangements are as indicated.
- B Report discrepancies to Architect before disturbing existing installation.

**3.02 PREPARATION**

- A Disconnect electrical systems in walls, floors, and ceilings to be removed.
- B Coordinate utility service outages with utility company.
- C Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.
- D Existing Electrical Service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Minimize outage duration.
  - 1. Obtain permission from Owner at least 48 hours before de-energizing system.
- E Fire alarm system shall be maintained to all occupied portions of the building.
  - 1. Notify Owner and Fire Marshall a least 48 hours before partially or completely disabling system.
  - 2. If the Fire alarm system cannot be maintained in the occupied portion of the building contractor shall provide a fire watch in accordance with NFPA 72 and local authority requirements.

**3.03 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK**

- A Perform work for removal and disposal of equipment and materials containing toxic substances regulated under the Federal Toxic Substances Control Act (TSCA) in accordance with applicable federal, state, and local regulations. Lamps are to be disposed of in accordance with NC G.S. 130A - 310.60. Applicable equipment and materials include, but are not limited to:
  - 1. PCB-containing electrical equipment, including transformers, capacitors, and switches.
  - 2. PCB- and DEHP-containing lighting ballasts.
  - 3. Mercury-containing lamps and tubes, including fluorescent lamps, high intensity discharge (HID), arc lamps, ultra-violet, high pressure sodium, mercury vapor, ignitron tubes, neon, and incandescent.
- B Remove, relocate, and extend existing installations to accommodate new construction.
- C Remove abandoned wiring to source of supply.
- D Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Where conduit cannot be removed from floors or walls, cut conduit flush with walls and floors, and patch surfaces.
- E Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets that are not removed.
- F Disconnect and remove abandoned panelboards and distribution equipment.
- G Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.
- H Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories.
- I Repair adjacent construction and finishes damaged during demolition and extension work.
- J Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.
- K Remove all devices from walls or ceilings shown to be removed on the Architectural drawings whether shown on the electrical demolition plans or not.
- L Where existing downstream devices are to remain, extend existing branch circuit conduit and conductors to maintain service.
- M Extend existing installations using materials and methods as specified.

**3.04 CLEANING AND REPAIR**

- A Clean and repair existing materials and equipment that remain or that are to be reused.

**END OF SECTION 26 05 05**



**SECTION 26 05 19**  
**POWER CONDUCTORS AND CABLES**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A Single conductor building wire.
- B Underground feeder and branch-circuit cable.
- C Wiring connectors.
- D Electrical tape.
- E Oxide inhibiting compound.
- F Wire pulling lubricant.

**1.02 REFERENCE STANDARDS**

- A ASTM B3 - Standard Specification for Soft or Annealed Copper Wire; 2013 (Reapproved 2018).
- B ASTM B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft; 2011 (Reapproved 2017).
- C ASTM B33 - Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes; 2010, with Editorial Revision (2020).
- D ASTM B787/B787M - Standard Specification for 19 Wire Combination Unilay-Stranded Copper Conductors for Subsequent Insulation; 2004 (Reapproved 2020).
- E NFPA 70 - National Electrical Code; National Fire Protection Association, Including All Applicable Amendments and Supplements; 2020.

**1.03 SUBMITTALS**

- A 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.
- B Field Quality Control Test Reports.
- C Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- D Project Record Documents: Record actual installed circuiting arrangements. Record actual routing of exterior below grade conduit and associated hand holes or man holes..
- E Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

**1.04 QUALITY ASSURANCE**

- A Comply with requirements of NFPA 70.
- B Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum five years documented experience.
- C Product Listing Organization Qualifications: Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to label Electrical and Mechanical Equipment.

**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.
- C Nonmetallic-sheathed cable is not permitted.
- D Service entrance cable is not permitted.

**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 All conductors shall be labeled two feet on centers indicating size, type, voltage, rating, and manufacturer's name.
- D Provide new conductors and cables manufactured not more than one year prior to installation.
- E Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.
- F Comply with NEMA WC 70.
- G Conductor Material:
  - 1. Provide copper conductors only! Conductor sizes indicated are based on copper.
  - 2. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors.
- H Minimum Conductor Size: 12 AWG.
- I Maximum Conductor Size: 500 kcmil
- J Conductors for branch circuits shall be sized to prevent a voltage drop exceeding three percent (3%) at the farthest outlet of power, heating and lighting loads, or any combination of such loads. The maximum total voltage drop on both feeders and branch circuits to the farthest outlet shall not exceed five percent (5%).
  - 1. Where the branch circuit conductor length from the panel to the first outlet on a 277 volt circuit exceeds 125 feet, the branch circuit conductors from the panel to the first outlet shall not be smaller than #10 AWG. Increase the branch circuit conductor size an additional wire size for reach 125' of additional length of the entire circuit. The ground conductor size shall be increased proportionately to the increase in the phase conductors per 2020 NEC 250.122(B).
  - 2. Where the conductor length from the panel to the first outlet on a 120 volt circuit exceeds 50 feet, the branch circuit conductors from the panel to the first outlet shall not be smaller than #10 AWG. Increase the branch circuit conductor size an additional wire size for reach 100' of additional length of the entire circuit. The ground conductor size shall be increased proportionately to the increase in the phase conductors per 2020 NEC 250.122(B).
- K 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:
    - a. Conductors #10 AWG and smaller shall be factory color coded.
    - b. Conductors #3 and larger shall be factory color coded on the entire length.
  - 3. Color Code:
    - a. 208Y/120 V, 3 Phase, 4 Wire System:
      - 1) Phase A: Black.
      - 2) Phase B: Red.
      - 3) Phase C: Blue.
      - 4) Neutral/Grounded: White.
    - b. Equipment Ground, All Systems: Green.
    - c. 0 - 10V Dimming conductors: Violet and Grey

### 2.03 BUILDING WIRE

- A Approved Manufacturers as listed below or approved equal:
  - 1. Copper Building Wire:
    - a. Triangle
    - b. Okonite
    - c. Houston Wire and Cable
    - d. or approved equal
- B Description: Single conductor insulated wire.
- C Conductor Stranding:
  - 1. Feeders and Branch Circuits:
    - a. Size 10 AWG and Smaller: Solid.
    - b. Size 8 AWG and Larger: Class B Stranded.
- D Insulation Voltage Rating: 600 V.

- E Insulation:
  - 1. Copper Building Wire: Type THHN/THWN or XHHW-2.
  - 2. Conductors routed on roofs or other exterior surface where raceway is exposed to direct sunlight shall be type XHHW-2 insulation.

#### 2.04 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 Connectors for Grounding and Bonding: Comply with Section 26 05 26.
- C Wiring Connectors for Splices and Taps:
  - 1. Splices or taps shall not be allowed for feeder conductors unless specifically noted on plans.
  - 2. Where a splice or tap for feeder conductors is noted on the plans, connectors shall be Blackburn insulated multi-tap or approved equal.
  - 3. Splices in branch circuit conductors shall be allowed in accessible junction boxes, troughs, or gutters.
    - a. Copper Conductors #10 AWG and smaller: Use twist-on insulated spring connectors.
    - b. Copper Conductors #8 AWG and larger: Use mechanical connectors with gum rubber tape or friction tape. Solderless mechanical connectors with UL listed insulating covers may be used at contractor's option.
  - 4. Use of split bolts is not allowed.
  - 5. "Sta-kon" or other permanent type crimp connectors shall not be used for branch circuit connections.
- D 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. Where over-sized conductors are larger than the equipment terminations can accommodate, provide connectors suitable for reducing to appropriate size, but not less than required for the rating of the overcurrent protective device.
- E 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.

#### 2.05 ACCESSORIES

- A Electrical Tape:
  - 1. Vinyl Color Coding Electrical Tape: Integrally colored to match color code indicated; listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; suitable for continuous temperature environment up to 221 degrees F.
    - a. Product: Okonite 2000 or approved equal.
  - 2. 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: Listed; suitable for use with the conductors or cables to be installed and suitable for use at the installation temperature.

### PART 3 EXECUTION

#### 3.01 EXAMINATION

- A Verify that interior of building has been protected from weather.
- B Verify that work likely to damage wire and cable has been completed.
- C Verify that raceways, boxes, and equipment enclosures are installed and are properly sized to accommodate conductors and cables in accordance with NFPA 70.
- D Verify that field measurements are as indicated.
- E 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. Circuit routing indicated is diagrammatic.
  - 2. Maintain separation of Class 1, Class 2, and Class 3 remote-control, signaling, and power-limited circuits in accordance with NFPA 70.
  - 3. 0 - 10V lighting dimming conductors may not be routed in the same raceway with line voltage conductors.
  - 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.
  - 6. A dedicated green equipment grounding conductor shall be provided for all raceways containing branch circuit or feeder conductors. Equipment ground conductor shall be sized in accordance with the NEC.
- B Install products in accordance with manufacturer's instructions.
- C Install conductors and cable in a neat and workmanlike manner. Neatly train and lace wiring inside boxes, equipment, and panelboards.
- 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 for conductors #4 AWG or larger, 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 Install conductors with a minimum of 12 inches of slack at each outlet.
- H Neatly train conductors inside boxes, wireways, panelboards and other equipment enclosures. Conductors shall not be laced or bundled to avoid overheating.
- I Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.
- J Make wiring connections using specified wiring connectors.
  - 1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.
  - 2. Do not remove conductor strands to facilitate insertion into connector.
  - 3. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminants. Do not use wire brush on plated connector surfaces.
- K Insulate ends of spare conductors using vinyl insulating electrical tape.
- L 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 All tests shall be completely documented indicating time of day, date, temperature and all pertinent test information. All required documentation shall be submitted to the Engineer prior to, and as a prerequisite for, final acceptance of the project. All test results shall be included in the Owner's operation and maintenance manual.
- B Inspect and test in accordance with NETA ATS, Section 7.3.2.
  - 1. Perform each of the following visual and electrical tests:
    - a. Compare cable data with drawings and specifications to ensure compliance with contract documents.

- b. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.
  - c. Test bolted connections for high resistance using one of the following:
    - 1) A low-resistance ohmmeter.
    - 2) Calibrated torque wrench.
  - d. Inspect compression-applied connectors for correct cable match and indentation.
  - e. Inspect for correct identification.
  - f. Inspect cable jacket and condition.
  - g. Continuity test on each conductor and cable.
  - h. Uniform resistance of parallel conductors.
- C Insulation resistance test is required for all feeder conductors prior to energizing feeders, sub-feeders, or service entrance conductors.
- 1. All current carrying feeder phase conductors and neutrals shall be tested as installed, and before connections are made, for insulation resistance and accidental grounds. This shall be done with a 500 volt insulation resistance tester. In the procedures listed below shall be followed:
    - a. Minimum readings shall be one million (1,000,000) or more ohms for #6 AWG wire and smaller, 250,000 ohms or more for #4 AWG wire or larger, between conducts and between conductor and the grounding conductor.
    - b. After all fixtures, devices and equipment are installed and all connections completed to each panel, the Contractor shall disconnect the neutral feeder conductor from the neutral bar and take a insulation resistance reading between the neutral bar and the grounded enclosure. If this reading is less than 250,000 ohms, the Contractor shall disconnect the branch circuit neutral wires from this neutral bar. He shall then test each one separately to the panel and until the low readings are found. The Contractor shall correct troubles, reconnect and retest until at 250,000 ohms from the neutral bar to the grounded panel can be achieved with only the neutral feeder disconnected.
    - c. The Contractor shall send a letter to the Engineer certifying that the above has been done and tabulating the insulation resistance readings for each panel. This shall be done at least four (4) days prior to final inspection.
    - d. At final inspection, The Contractor shall furnish a insulation resistance tester and show the Engineer's representatives that the panels comply with the above requirements. He shall also furnish a hook-on type ammeter and voltmeter to take current and voltage readings as directed by the representatives.
    - e. Results of the test shall be made available to the engineer at the required pre-energization walk through.
  - 2. Disconnect surge protective devices (SPDs) prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPDs connected.
- D Correct deficiencies and replace damaged or defective conductors and cables and re-test as indicated above. Contractor shall submit new test results to the Engineer to demonstrate the deficiency has been corrected.

**END OF SECTION 26 05 19**

**SECTION 26 05 26**  
**GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A Grounding and bonding requirements.
- B Conductors for grounding and bonding.
- C Connectors for grounding and bonding.
- D Ground bars.
- E Ground rod electrodes.

**1.02 REFERENCE STANDARDS**

- A IEEE 81 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System; 2012.
- B NEMA GR 1 - Grounding Rod Electrodes and Grounding Rod Electrode Couplings; 2022.
- C NETA ATS - Standard For Acceptance Testing Specifications For Electrical Power Equipment And Systems; 2021.
- D NFPA 70 - National Electrical Code; National Fire Protection Association, Including All Applicable Amendments and Supplements; 2020.
- E UL 467 - Grounding and Bonding Equipment; Current Edition, Including All Revisions.

**1.03 ADMINISTRATIVE REQUIREMENTS**

- A Coordination:
  - 1. Verify exact locations of underground metal water service pipe entrances to building.
  - 2. Coordinate the work with other trades to provide steel reinforcement complying with specified requirements for concrete-encased electrode.
  - 3. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B Sequencing:
  - 1. Do not install ground rod electrodes until final backfill and compaction is complete.

**1.04 SUBMITTALS**

- A Product Data: Provide manufacturer's standard catalog pages and data sheets for grounding and bonding system components.
- B Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- C Field quality control test reports.
- D Project Record Documents: Record actual locations of grounding electrode system components and connections.

**1.05 QUALITY ASSURANCE**

- A Comply with requirements of NFPA 70.
- B Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- C Product Listing Organization Qualifications: Third party agencies shall be amongst those accredited by the NCBC (North Carolina Building Code Council) to label Electrical and Mechanical Equipment.

**1.06 DELIVERY, STORAGE, AND HANDLING**

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

**PART 2 PRODUCTS**

**2.01 GROUNDING AND BONDING REQUIREMENTS**

- A Existing Work: Where existing grounding and bonding system components are indicated to be reused, they may be reused only where they are free from corrosion, integrity and continuity are verified, and where acceptable to the authority having jurisdiction.
- B Do not use products for applications other than as permitted by NFPA 70 and product listing.
- C Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding

- system.
- D Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
  - E Grounding System Resistance:
    - 1. Achieve specified grounding system resistance under normally dry conditions unless otherwise approved by Architect. Precipitation within the previous 48 hours does not constitute normally dry conditions.
    - 2. Grounding Electrode System: Not greater than 5 ohms to ground, when tested according to IEEE 81 using "fall-of-potential" method.
    - 3. Between Grounding Electrode System and Major Electrical Equipment Frames, System Neutral, and Derived Neutral Points: Not greater than 0.5 ohms, when tested using "point-to-point" methods.
  - F Grounding Electrode System:
    - 1. Provide connection to required and supplemental grounding electrodes indicated to form grounding electrode system.
      - a. Provide continuous grounding electrode conductors without splice or joint.
      - b. Install grounding electrode conductors in raceway where exposed to physical damage. Bond grounding electrode conductor to metallic raceways at each end with bonding jumper.
    - 2. Metal Underground Water Pipe(s):
      - a. Provide connection to underground metal domestic and fire protection (where present) water service pipe(s) that are in direct contact with earth for at least 10 feet at an accessible location not more than 5 feet from the point of entrance to the building.
      - b. Provide bonding jumper(s) around insulating joints/pipes as required to make pipe electrically continuous.
      - c. Provide bonding jumper around water meter of sufficient length to permit removal of meter without disconnecting jumper.
    - 3. Metal In-Ground Support Structure:
      - a. Provide connection to metal in-ground support structure that is in direct contact with earth in accordance with NFPA 70.
    - 4. Concrete-Encased Electrode:
      - a. Where metallic structural components meet the definition of a concrete encased electrode as defined in NEC 250.52, the concrete encased electrode shall be bonded to the grounding electrode system per NEC 250.50. Coordinate with the structure prior to pouring concrete foundations.
      - b. Provide connection to concrete-encased electrode consisting of not less than 20 feet of either steel reinforcing bars or bare copper conductor not smaller than 4 AWG embedded within concrete foundation or footing that is in direct contact with earth in accordance with NFPA 70.
    - 5. Ground Rod Electrode(s):
      - a. Space electrodes not less than 10 feet from each other and any other ground electrode until maximum allowed resistance to ground is achieved.
      - b. Where location is not indicated, locate electrode(s) at least 5 feet outside building perimeter foundation as near as possible to electrical service entrance; where possible, locate in softscape (uncovered) area.
    - 6. Provide additional ground electrode(s) as required to achieve specified grounding electrode system resistance.
    - 7. Ground Bar: Provide ground bar in main electrical room, separate from service equipment enclosure, for common connection point of grounding electrode system bonding jumpers as permitted in NFPA 70. Connect grounding electrode conductor provided for service-supplied system grounding to this ground bar.
      - a. Ground Bar Size: 1/4" x 2" x 18" unless otherwise indicated or required.
      - b. Where ground bar location is not indicated, locate in accessible location as near as possible to service disconnect enclosure.
    - 8. unless otherwise noted. Location as identified on plans.

9. Ground Riser: Provide common grounding electrode conductor not less than 3/0 AWG for tap connections to multiple separately derived systems as permitted in NFPA 70.
- G Service-Supplied System Grounding:
1. For each service disconnect, provide grounding electrode conductor to connect neutral (grounded) service conductor to grounding electrode system. Unless otherwise indicated, make connection at neutral (grounded) bus in service disconnect enclosure.
  2. For each service disconnect, provide main bonding jumper to connect neutral (grounded) bus to equipment ground bus where not factory-installed. Do not make any other connections between neutral (grounded) conductors and ground on load side of service disconnect.
- H Separately Derived System Grounding:
1. Separately derived systems include, but are not limited to:
    - a. Transformers.
  2. Provide grounding electrode conductor to connect derived system grounded conductor to nearest effectively grounded metal building frame. Unless otherwise indicated, make connection at neutral (grounded) bus in source enclosure.
  3. Provide bonding jumper to connect derived system grounded conductor to nearest metal building frame and nearest metal water piping in the area served by the derived system, where not already used as a grounding electrode for the derived system. Make connection at same location as grounding electrode conductor connection.
  4. Where common grounding electrode conductor ground riser is used for tap connections to multiple separately derived systems, provide bonding jumper to connect the metal building frame and metal water piping in the area served by the derived system to the common grounding electrode conductor.
  5. Provide system bonding jumper to connect system grounded conductor to equipment ground bus. Make connection at same location as grounding electrode conductor connection. Do not make any other connections between neutral (grounded) conductors and ground on load side of separately derived system disconnect.
- I Bonding and Equipment Grounding:
1. Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70.
  2. Provide insulated equipment grounding conductor in each feeder and branch circuit raceway. Do not use raceways as sole equipment grounding conductor.
  3. Where circuit conductor sizes are increased for voltage drop, increase size of equipment grounding conductor proportionally in accordance with NFPA 70.
  4. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
  5. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on neutral (grounded) or isolated/insulated ground bus.
  6. Provide bonding jumper across expansion or expansion/deflection fittings provided to accommodate conduit movement.
  7. Provide bonding for interior metal piping systems in accordance with NFPA 70. This includes, but is not limited to:
    - a. Metal water piping where not already effectively bonded to metal underground water pipe used as grounding electrode.
    - b. Metal gas piping.
- J Communications Systems Grounding and Bonding:
1. Provide intersystem bonding termination at service equipment or metering equipment enclosure and at disconnecting means for any additional buildings or structures in accordance with NFPA 70.
  2. Provide bonding jumper in raceway from intersystem bonding termination to each communications room or backboard and provide ground bar for termination.
    - a. Bonding Jumper Size: #3/0 AWG.



- b. Raceway Size: 1" trade size unless otherwise indicated or required.
- c. Ground Bar Size: 1/4" x 2" x 18" unless otherwise indicated or required.
- d. Ground Bar Mounting Height: 18 inches above finished floor unless otherwise indicated.

## 2.02 GROUNDING AND BONDING COMPONENTS

### A General Requirements:

1. Provide products listed, classified, and labeled as suitable for the purpose intended.
2. Provide products listed and labeled as complying with UL 467 where applicable.

### B Conductors for Grounding and Bonding, in Addition to Requirements of Section 26 05 26:

1. Use insulated copper conductors unless otherwise indicated.
  - a. Exceptions:
    - 1) Use bare copper conductors where installed underground in direct contact with earth.
    - 2) Use bare copper conductors where directly encased in concrete (not in raceway).
  2. Where insulated grounding conductors are used conductors shall be colored solid green.
  3. Grounding electrode conductors #4 AWG and larger shall be installed in raceway.

### C Connectors for Grounding and Bonding:

1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.
2. Unless otherwise indicated, use exothermic welded connections for underground, concealed and other inaccessible connections.
3. Unless otherwise indicated, use double crimp compression connectors or exothermic welded connections for accessible connections.

### D Ground Bars:

1. Description: Copper rectangular ground bars with mounting brackets and insulators.
2. Size: As indicated elsewhere in this section.
3. Holes for Connections: All mechanical connectors shall be double hole double crimp compression connectors..

### E Ground Rod Electrodes:

1. Comply with NEMA GR 1.
2. Material: Copper-bonded (copper-clad) steel.
3. Size: 3/4 inch diameter by 10 feet length, unless otherwise indicated.

## PART 3 EXECUTION

### 3.01 EXAMINATION

- A Verify that work likely to damage grounding and bonding system components has been completed.
- B Verify that field measurements are as indicated.
- 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 grounding and bonding system components in a neat and workmanlike manner.
- C Boxes with concentric, eccentric or oversized knockouts shall be provided with bonding bushings and jumpers. The jumper shall be sized per NEC table 250-122 and lugged to the box.
- D Ground Rod Electrodes: Unless otherwise indicated, install ground rod electrodes vertically. Where encountered rock prohibits vertical installation, install at 45 degree angle.
  1. Outdoor Installations: Unless otherwise indicated, install with top of rod 6 inches below finished grade.
- E Make grounding and bonding connections using specified connectors.
  1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.
  2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
  3. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.

4. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.  
Connectors must be UL listed for use with grounding electrode conductors.

F Identify grounding and bonding system components in accordance with Section 26 05 53.

### 3.03 FIELD QUALITY CONTROL

- A Inspect and test in accordance with NETA ATS Section 7.13.
  1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
  2. Verify that ground system was installed in accordance with the contract documents and NEC Article 250.
  3. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
    - a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
  4. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal at ground test wells and at individual ground rods. Make tests at ground rods before any conductors are connected.
    - a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
    - b. Perform tests by fall-of-potential method according to IEEE 81.
- B Perform ground electrode resistance tests under normally dry conditions. Precipitation within the previous 48 hours does not constitute normally dry conditions.
- C Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements.
- D Submit detailed reports indicating inspection and testing results and corrective actions taken.

**END OF SECTION 26 05 26**

**SECTION 26 05 29**  
**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 RELATED REQUIREMENTS**

- A Section 26 05 33.13 - Conduit for Electrical Systems: Additional support and attachment requirements for conduits.
- B Section 26 05 36 - Cable Trays for Electrical Systems: Additional support and attachment requirements for cable tray.
- C Section 26 05 33.16 - Boxes and Cabinets: Additional support and attachment requirements for boxes.

**1.03 REFERENCE STANDARDS**

- A NFPA 70 - National Electrical Code; National Fire Protection Association, Including All Applicable Amendments and Supplements; 2020.

**1.04 ADMINISTRATIVE REQUIREMENTS**

- A Coordination:
- B Sequencing:

**1.05 SUBMITTALS**

- A Product Data: Provide manufacturer's standard catalog pages and data sheets for channel (strut) framing systems, non-penetrating rooftop supports, and post-installed concrete and masonry anchors.
- B Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

**1.06 QUALITY ASSURANCE**

**1.07 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 electrical 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 products for applications other than as permitted by NFPA 70 and product listing.
- B Conduit and Cable Supports: Straps, clamps, etc. suitable for the 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 Anchors and Fasteners:
  - 1. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
  - 2. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
  - 3. Hollow Masonry: Use toggle bolts.
  - 4. Hollow Stud Walls: Use toggle bolts.
  - 5. Steel: Use beam clamps, machine bolts, or welded threaded studs.
  - 6. Sheet Metal: Use sheet metal screws, bolts, or bolts.
  - 7. Wood: Use wood screws.
  - 8. Plastic and lead anchors are not permitted.
  - 9. 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 Perform work in accordance with NECA 1 (general workmanship).
- C Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
- D 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. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
- H Conduits installed on the interior of exterior building walls shall be spaced off the wall surface a minimum of 1/4 inch using "clamp-backs" or strut.
- I Remove temporary supports.

**3.03 FIELD QUALITY CONTROL**

- A Inspect support and attachment components for damage and defects.
- 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 support and attachment components.

**END OF SECTION 26 05 29**

**SECTION 26 05 33.13**  
**CONDUIT FOR ELECTRICAL SYSTEMS**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A Galvanized steel rigid metal conduit (RMC).
- B Flexible metal conduit (FMC).
- C Liquidtight flexible metal conduit (LFMC).
- D Electrical metallic tubing (EMT).
- E Rigid polyvinyl chloride (PVC) conduit.
- F Conduit fittings.
- G Accessories.

**1.02 REFERENCE STANDARDS**

- A ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC); 2020.
- B ANSI C80.3 - American National Standard for Electrical Metallic Tubing -- Steel (EMT-S); 2020.
- C ANSI C80.6 - American National Standard for Electrical Intermediate Metal Conduit; 2018.
- D ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2019.
- E ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2016a.
- F ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.
- G NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT); 2020.
- H NECA 111 - Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC); 2017.
- I NFPA 70 - National Electrical Code; National Fire Protection Association, Including All Applicable Amendments and Supplements; 2020.

**1.03 ADMINISTRATIVE REQUIREMENTS**

- A Coordination:
  - 1. Coordinate minimum sizes of conduits with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
  - 2. Coordinate the arrangement of conduits with structural members, ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
  - 3. Verify exact conduit termination locations required for boxes, enclosures, and equipment installed under other sections or by others.
  - 4. Coordinate the work with other trades to provide roof penetrations that preserve the integrity of the roofing system and do not void the roof warranty.
  - 5. Notify Architect of any 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 is complete between outlet, junction and splicing points.

**1.04 SUBMITTALS**

- A Product Data: Provide manufacturer's standard catalog pages and data sheets for conduits and fittings.
- B Project Record Documents: Record actual routing for conduits installed underground exterior to the building envelope.

**1.05 QUALITY ASSURANCE**

- A Conduit shall be delivered to the project site in bundles of full length pipes, each length marked with the trademark of the manufacturer and the Underwriters' Laboratories, Inc. stamp. Each conduit length shall be straight, true and free from scales, blisters, burrs and other imperfections.
  - 1. Product Listing Organization Qualifications: Third party agencies shall be amongst those accredited by the NCBC (North Carolina Building Code Council) to label Electrical and Mechanical Equipment.

**1.06 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 and product listing.
- B Unless otherwise indicated and where not otherwise restricted, use the conduit types indicated for the specified applications.
- C Embedded Within Concrete:
  - 1. Within Slab on Grade: Not permitted.
  - 2. Within Slab Above Ground: Not permitted.
  - 3. Within Poured Concrete Walls Above Ground: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), PVC-coated galvanized steel rigid metal conduit, rigid PVC conduit, or reinforced thermosetting resin conduit (RTRC).
- D Outdoors: Apply raceways as indicated below unless otherwise noted
  - 1. Above ground conduit: Rigid galvanized steel conduit with 90 degree rigid elbow below grade transition to PVC.
  - 2. Roof: Rigid galvanized steel conduit supported on rubber blocks and unistrut frame. Conduit must be at least 3-1/2" above roof surface.
  - 3. Feeders: PVC Type DB concrete encased
  - 4. Branch circuits: Schedule 40 PVC direct buried
  - 5. Telecommunications: Schedule 40 PVC concrete encased
  - 6. Connections to vibrating equipment including transformers, generators, and other motor driven equipment: Liquid tight flexible metal conduit.
  - 7. Boxes and enclosures above ground Nema Type 4
  - 8. Where rigid polyvinyl (PVC) conduit is used for feeder conductors, transition to galvanized steel rigid metal conduit a minimum of three feet horizontally prior to emerging from underground.
  - 9. Where rigid polyvinyl (PVC) conduits used for branch circuits, use galvanized steel rigid metal conduit elbows for bends.
- E Indoors: Finished spaces (not subject to physical damage)
  - 1. Raceway shall be routed concealed in interior portions of furred spaces, ceilings, and cavities, unless other than concrete or solid plaster where possible.
  - 2. Raceways 2 inch or less shall be allowed to be EMT conduit.
  - 3. All raceways concealed in exterior walls shall be rigid galvanized steel conduit.
  - 4. All raceways larger than 2 inch shall be rigid galvanized conduit.
  - 5. Where surface mounted conduit is required in finished spaces, contractor shall utilize surface metal raceway wire mold.
  - 6. Where there is a transition between RGS in a wall to EMT above ceiling, it shall be made at a junction box above accessible ceiling.
  - 7. Interior, Damp or Wet Locations: Use galvanized steel rigid metal conduit.
- F Stub Ups
  - 1. All feeder stub ups shall transition below grade from PVC to rigid a minimum of 3 feet horizontally from stub up location.
  - 2. All branch circuit stub ups, where exposed or in non-CMU walls, shall transition to rigid galvanized steel at 90 degree elbow.
  - 3. Schedule 40 rigid polyvinyl (PVC) stub ups are only allowed where conduits come up in CMU walls or the bottom of floor mounted equipment.
- G Unfinished spaces subject to damage (Electrical, Mechanical etc.)
  - 1. All conduit in unfinished spaces shall rigid galvanized steel. Conduit is not considered subject to damage when installed at least 10 feet above finished floor or tight to structure.
  - 2. Conduits are not required to transition to rigid galvanized steel where they are routed down into panelboards or other wall mounted equipment.
- H Exposed, Interior finished spaces: Use surface metal raceway as identified on the drawings.
  - 1. Surface metal raceway shall be manufactured by Wiremold or approved equal.

2. A separate equipment ground conductor shall be run in the surface metal raceway.
- I Connection to vibrating equipment shall be made with flexible metal conduit or liquid tight flexible metal conduit depending on the environment installed.
- J Connections to Luminaires Above Accessible Ceilings: Use flexible metal conduit shall be allowed.
  1. Maximum Length: 6 feet.
- K Connections to Vibrating Equipment:
  1. Dry Locations: Use flexible metal conduit.
  2. Damp, Wet, or Corrosive Locations: Use liquidtight flexible metal conduit.
  3. Maximum Length: 6 feet unless otherwise indicated.
  4. Vibrating equipment includes, but is not limited to:
    - a. Transformers.
    - b. Motors.

## 2.02 CONDUIT REQUIREMENTS

- A 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 a mandrel through them.
- B Provide all conduit, fittings, supports, and accessories required for a complete raceway system.
- C Provide products listed, classified, and labeled as suitable for the purpose intended.
- D Minimum Conduit Size, Unless Otherwise Indicated:
  1. Interior: 3/4 inch (21 mm) trade size.
  2. Flexible Connections to Luminaires: 1/2 inch ( 13 mm) trade size.
  3. Exterior: 1 inch (27 mm) trade size.

## 2.03 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

- A Manufacturers:
  1. Allied Tube & Conduit.
  2. Republic Conduit.
  3. Wheatland Tube Company.
  4. or approved equal.
- B Description: NFPA 70, Type RMC standard weight mild steel, hot dipped galvanized, sherardised or zinc-coated rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.
- C Fittings:
  1. Manufacturers:
    - a. Thomas & Betts Corporation.
    - b. Rayco.
    - c. Appleton.
    - d. or approved equal.
  2. Connectors and Couplings: Use steel compression fittings with insulated throats.

## 2.04 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. Non-Hazardous Locations: Use 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 threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

## 2.05 FLEXIBLE METAL CONDUIT AND LIQUIDTIGHT FLEXIBLE METAL CONDUIT (FMC LFMC)

- A Manufacturers:
  1. Allied Tube & Conduit.
  2. Republic Conduit.
  3. Wheatland Tube Company.
  4. or approved equal.

- B 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 to be used.
- C Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.
- D Spiral strip construction shall allow the conduit to bend up to four times its internal radius.
- E Fittings shall be compression type with insulated throats and listed for use with conduit specified.

## **2.06 ELECTRICAL METALLIC TUBING (EMT)**

- A Manufacturers:
  - 1. Allied Tube & Conduit.
  - 2. Republic Conduit.
  - 3. Wheatland Tube Company.
  - 4. or approved equal.
- B Description: NFPA 70, Type EMT cold-rolled steel electrical metallic tubing with zinc coating on the inside and protected on the inside by a zinc, enamel or equivalent corrosion-resistant coating complying with ANSI C80.3 and listed and labeled as complying with UL 797.
- C 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 hexagonal compression (gland) type.
    - a. Do not use indenter type connectors and couplings.
    - b. Do not use set-screw type connectors and couplings.

## **2.07 RIGID POLYVINYL CHLORIDE (PVC) CONDUIT**

- A Manufacturers:
  - 1. Allied Tube & Conduit.
  - 2. Republic Conduit.
  - 3. Wheatland Tube Company.
  - 4. or approved equal.
- B Description: NFPA 70, Type PVC rigid polyvinyl chloride conduit complying with NEMA TC 2 and listed and labeled as complying with UL 651; Schedule 40 or Schedule 80 as indicated; rated for use with conductors rated 90 degrees C.
- C Fittings:
  - 1. Manufacturer: Same as manufacturer of conduit to be connected.
  - 2. Description: Fittings complying with NEMA TC 3 and listed and labeled as complying with UL 651; material to match conduit.

## **2.08 ACCESSORIES**

- A Corrosion Protection Tape: PVC-based, minimum thickness of 20 mil.
- B Conduit Joint Compound: Corrosion-resistant, electrically conductive; suitable for use with the conduit to be installed.
- C Solvent Cement for PVC Conduit and Fittings: As recommended by manufacturer of conduit and fittings to be installed.
- D Pull Strings: Use nylon cord with average breaking strength of not less than 200 pound-force.

## **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 a neat and workmanlike manner tight against walls, columns or ceilings.
- C The conduit shall bend cold 90 degrees about a radius equal to ten (10) times its own diameter without signs of flaw or fracture in either pipe or protective coverings. All bends and offsets shall be made on a forming tool to prevent the conduit or its coating from being damaged in the bending.



- D Install galvanized steel rigid metal conduit (RMC) in accordance with NECA 101.
- E Install intermediate metal conduit (IMC) in accordance with NECA 101.
- F Install PVC-coated galvanized steel rigid metal conduit (RMC) using only tools approved by the manufacturer.
- G Install rigid polyvinyl chloride (PVC) conduit in accordance with NECA 111.
- H Conduit Routing:
  - 1. Unless dimensioned, conduit routing indicated is diagrammatic.
  - 2. Conceal all conduits unless specifically indicated to be exposed.
  - 3. Conduits in the following areas may be exposed, unless otherwise indicated:
    - a. Electrical rooms.
    - b. Mechanical equipment rooms.
  - 4. Arrange conduit to maintain maximum headroom, clearances, and access.
  - 5. Arrange conduit to provide no more than the equivalent of four 90 degree bends between pull points.
  - 6. Arrange conduit to provide no more than 100 feet between pull points.
  - 7. In every instance, conduit shall be installed in such a manner that the conductors may readily and easily be drawn or pulled in without strain or damage to the insulation; and, also, so that defective conductors may be readily and easily withdrawn and replaced by new conductors. Long radius bends and a sufficient number of approved pull and junction boxes shall be approved for this purpose, and as may be directed by the Engineer. All conduit shall be securely supported and grounded.
  - 8. Arrange conduit to prevent moisture traps. Provide drain fittings at low points and at sealing fittings where moisture may collect.
  - 9. Where conduits join any couplings or threaded fittings, the ends shall be made watertight.
  - 10. Maintain minimum clearance of 12 inches between conduits and hot surfaces. This includes, but is not limited to:
- I Conduit Support:
  - 1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of electrical work.
  - 2. Secure and support conduits in accordance with NFPA 70 and Section 26 05 29 using suitable supports and methods approved by the authority having jurisdiction.
  - 3. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
  - 4. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conduits to lay on ceiling tiles.
  - 5. Use conduit strap to support single surface-mounted conduit.
    - a. Use clamp back spacer with conduit strap for damp and wet locations to provide space between conduit and mounting surface.
  - 6. Use metal channel (strut) with accessory conduit clamps to support multiple parallel surface-mounted conduits.
  - 7. Use conduit clamp to support single conduit from beam clamp or threaded rod.
  - 8. Use trapeze hangers assembled from threaded rods and metal channel (strut) with accessory conduit clamps to support multiple parallel suspended conduits.
  - 9. 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 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.
  - 10. Metal Channel (Strut) Framing Systems: Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
    - a. Minimum Channel Thickness: Steel sheet, 12 gage, 0.1046 inch.
    - b. Minimum Channel Dimensions: 1-5/8 inch width by 13/16 inch height.

- J 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. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.
  5. Provide insulating bushings or insulated throats at all conduit terminations to protect conductors.
  6. Secure joints and connections to provide maximum mechanical strength and electrical continuity.
  7. Condulet fittings shall not be used in lieu of pull boxes.
- K Penetrations:
1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams.
  2. Make penetrations perpendicular to surfaces unless otherwise indicated.
  3. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
    - a. All raceway penetrating exterior walls or other water proof membranes shall slope away from the building with a minimum slope of 4" over 100 feet.
  4. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as required to preserve integrity of roofing system and maintain roof warranty.
  5. Install firestopping to preserve fire resistance rating of partitions and other elements. Refer to penetration details on plans.
  6. Where conduits cross building expansion joints or pass between areas with a temperature difference of 14 degrees C, provide expansion fittings on all raceway.
- L Underground Installation:
1. Minimum Cover, Unless Otherwise Indicated or Required:
    - a. Underground, Exterior: 24 inches.
  2. Provide underground warning tape six to eight inches below finished grade directly above raceway. Tape shall be six inches wide with a minimum thickness of seven mil, non-distorting, colorfast, no-stretch, 600 pound tensile strength per six inch width, ultraviolet light fast. Message must repeat within a maximum of 40 inches. Painted legend shall be indicative of the type of underground line.
- M Concrete Encasement: Where conduits not otherwise embedded within concrete are indicated to be concrete-encased, provide concrete in accordance with Section 03 30 00 with minimum concrete cover of 3 inches on all sides unless otherwise indicated.
- N Ductbanks containing conductors of 600 volts or more shall be concrete encased with red dyed concrete.
- O 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 calculated in accordance with NFPA 70 for rigid polyvinyl chloride (PVC) conduit installed above ground to compensate for thermal expansion and contraction.
  3. Where conduits are subject to earth movement by settlement or frost.
- P Condensation Prevention: Where conduits cross barriers between areas of potential substantial temperature differential, provide sealing fitting or approved sealing compound at an accessible point near the penetration to prevent condensation. This includes, but is not limited to:
1. Where conduits pass from outdoors into conditioned interior spaces.
  2. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.
  3. Where conduits penetrate coolers or freezers.
- Q Provide 200 pound tensile strength pull string in all empty conduits and in conduits where conductors and cables are to be installed by others. Leave minimum slack of 12 inches at each end. All empty conduits shall terminate in a junction box.

- R All ducts shall be sealed at terminations, using sealing compound and plugs, as required to withstand 15 psi minimum hydrostatic pressure.

**3.03 FIELD QUALITY CONTROL**

- A Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
- B Where coating of PVC-coated galvanized steel rigid metal conduit (RMC) contains cuts or abrasions, repair in accordance with manufacturer's instructions.
- 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 05 33.13**

**SECTION 26 05 33.16**  
**BOXES AND CABINETS**

**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.

**1.02 REFERENCE STANDARDS**

- A NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2020.
- B NFPA 70 - National Electrical Code; National Fire Protection Association, Including All Applicable Amendments and Supplements; 2020.

**1.03 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.

**1.04 SUBMITTALS**

- A Product Data: Provide manufacturer's standard catalog pages and data sheets for outlet and device boxes, junction and pull boxes, cabinets and enclosures, and floor boxes.
- B Project Record Documents: Record actual locations for outlet and device boxes, cabinets and enclosures, and floor boxes.

**1.05 QUALITY ASSURANCE**

- A Product Listing Organization Qualifications: Third party agencies shall be amongst those accredited by the NCBC (North Carolina Building Code Council) to label Electrical and Mechanical Equipment.

**1.06 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. The Electrical Contractor shall provide junction boxes, pull boxes, cable, support boxes, and wiring troughs as required by NEC and as otherwise indicated in the Drawings.
  - 2. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.
  - 3. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.
  - 4. Provide products listed, classified, and labeled as suitable for the purpose intended.
  - 5. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
  - 6. Provide grounding terminals within boxes where equipment grounding conductors terminate.
  - 7. Each outlet designated on the plans shall be provided with an outlet box.

8. In general, outlets shall be installed at the heights indicated. The Contractor shall examine the plans of and coordinate with all other trades to assure mounting heights are correct for the intended purpose. Assure that all mounting heights comply with the latest version of ADA. Outlets installed at incorrect heights shall be relocated to the correct elevation at the Contractor's expense.
- 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. Outlet boxes shall be 4" square, 2 1/8" deep unless otherwise noted.
  4. Use suitable concrete type boxes where flush-mounted in concrete.
  5. Use suitable masonry type boxes where flush-mounted in masonry walls.
  6. Do not use "through-wall" boxes designed for access from both sides of wall.
  7. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
  8. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.
  9. Junction boxes larger than 4" square shall be galvanized and without pre-formed knockouts.
  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.
  12. Manufacturers Recessed:
    - a. Steel City Electric Company
    - b. Metropolitan
    - c. B & C
    - d. or approved equal.
  13. Manufacturers Surface:
    - a. Crouse-Hinds
    - b. Appleton
    - c. Rayco
    - d. or approved equal.
- C Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches:
  1. Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E, or UL 508A.
  2. NEMA 250 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.
    - b. Boxes 12" square and Larger: Provide hinged-cover enclosures with quick access latches.
  4. Cabinets and Hinged-Cover Enclosures, Other Than Junction and Pull Boxes:
    - a. Provide lockable hinged covers, all locks keyed alike unless otherwise indicated.
  5. Manufacturers Surface:
    - a. Cooper.
    - b. Hoffman.
    - c. Hubbell Incorporated.
    - d. or approved equal..

### **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 Perform work in a neat and workmanlike manner.
- C Arrange equipment to provide maximum clearances.

- D Unless otherwise indicated, provide separate boxes for line voltage and low voltage systems.
- E Flush-mount boxes in finished areas unless specifically indicated to be surface-mounted.
- F Box Locations:
  - 1. Locate boxes in accessible locations.
  - 2. Locate boxes so that wall plates do not span different building finishes.
  - 3. Locate boxes so that wall plates do not cross masonry joints.
  - 4. Unless otherwise indicated, where multiple outlet boxes are installed at the same location at different mounting heights, install along a common vertical center line.
  - 5. Do not install flush-mounted boxes on opposite sides of walls back-to-back. Provide minimum 6 inches horizontal separation unless otherwise indicated.
  - 6. Fire Resistance Rated Walls: Install flush-mounted boxes such that the required fire resistance will not be reduced.
- G Box Supports:
  - 1. Secure and support boxes in accordance with NFPA 70 and Section 26 05 29 using suitable supports and methods approved by the authority having jurisdiction.
- H Install boxes plumb and level.
- I 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.
- J Install boxes as required to preserve insulation integrity.
- K Boxes in damp or wet locations shall be provided with gaskets and covers.
- L Install permanent barrier between ganged wiring devices when voltage difference between adjacent devices exceeds 300 V.
- M Close unused box openings.
- N Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.

### 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 05 33.16

**SECTION 26 05 53**  
**IDENTIFICATION FOR ELECTRICAL SYSTEMS**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A Electrical identification requirements.
- B Identification nameplates and labels.
- C Wire and cable markers.
- D Underground warning tape.
- E Warning signs and labels.

**1.02 REFERENCE STANDARDS**

- A ANSI Z535.2 - American National Standard for Environmental and Facility Safety Signs; 2011 (Reaffirmed 2017).
- B ANSI Z535.4 - American National Standard for Product Safety Signs and Labels; 2011 (Reaffirmed 2017).
- C NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D UL 969 - Marking and Labeling Systems; Current Edition, Including All Revisions.

**1.03 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.

**1.04 SUBMITTALS**

- A Product Data: Provide manufacturer's standard catalog pages and data sheets for each product.
- B Shop Drawings: Provide schedule of items to be identified indicating proposed designations, materials, legends, and formats.

**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. Distribution Panelboard Service Entrance:
      - 1) Identify ampere rating.
      - 2) Identify voltage and phase.
      - 3) Identify power source and circuit number. Include location.
      - 4) Use identification nameplate to identify main overcurrent protective device.
      - 5) Use identification nameplate to identify load(s) served for each branch device where not identified in a panelboard schedule.
      - 6) Provide Maximum Fault Current Placard as per NEC 110.24.
    - b. Panelboards:
      - 1) Identify ampere rating.
      - 2) Identify voltage and phase.
      - 3) Identify power source and circuit number. Include location.
      - 4) Use typewritten circuit directory to identify load(s) served.
    - c. Enclosed switches, circuit breakers, and motor controllers:
      - 1) Identify voltage and phase.
      - 2) Identify power source and circuit number. Include location.
      - 3) Identify load(s) served. Include location.

- d. Enclosed Contactors:
    - 1) Identify ampere rating.
    - 2) Identify voltage and phase.
    - 3) Identify coil voltage.
    - 4) Identify load(s) and associated circuits controlled. Include location.
  2. Service Equipment:
    - a. For buildings or structures supplied by more than one service, or any combination of branch circuits, feeders, and services, use identification nameplate at each service disconnecting means to identify all other services, feeders, and branch circuits supplying that building or structure. Verify format and descriptions with authority having jurisdiction.
  3. Emergency System Equipment:
    - a. Use identification nameplate or voltage marker to identify emergency system equipment in accordance with NFPA 70.
  4. Use identification nameplate to identify disconnect location for equipment with remote disconnecting means.
  5. Available Fault Current Documentation: Use identification label to identify the available fault current and date calculations were performed at locations requiring documentation by NFPA 70 including but not limited to the following.
    - a. Service equipment.
  6. Arc Flash Hazard Warning Labels: Comply with Section 26 05 73.
- B Identification for Conductors and Cables:**
1. Color Coding for Power Conductors 600 V and Less: Comply with Section 26 05 19.
  2. Identification for Communications Conductors and Cables: Comply with Section 27 10 00.
  3. Use underground warning tape to identify power and communication feeders and branch circuits exterior to the building.
- C Identification for Boxes:**
1. Use color coded boxes to identify specified systems.
    - a. Color-Coded Boxes: Field-painted per the same color coding as identified in this section for the system contained within.
    - b. Fire alarm junction boxes shall be painted on all sides including the box cover.
  2. For boxes concealed above accessible ceilings or exposed in mechanical or electrical rooms use neatly handwritten text using indelible marker to identify circuits enclosed.
  3. For exposed boxes in public areas, use only type written labels.
- D Identification for Devices:**
1. Wiring Device and Wallplate Finishes: Comply with Section 26 27 26.
  2. Use identification label to identify fire alarm system devices.
  3. For devices concealed above suspended ceilings, provide additional identification on ceiling tile below device location.
  4. Use identification label to identify receptacles protected by upstream GFI protection, where permitted.
- E Color Coding**
1. Phenolic Nameplates and associated conduit and boxes shall be identified with the following color scheme. Note: For existing buildings the contractor shall field verify the existing building standard and revise the color scheme to match the existing field conditions. Failure to match existing conditions will result in the contractor correcting the mislabeled equipment at his expense.
    - a. Blue surface white core - 120/208V equipment.
    - b. Bright red surface white core - fire alarm equipment.
    - c. Dark red (burgundy) surface white core - security equipment.
    - d. Green surface white core - emergency systems.
    - e. Orange surface white core - telephone systems.
    - f. Brown surface white core - data systems.
    - g. White surface black core - paging systems.
    - h. Purple surface white core - TV systems.



## 2.02 IDENTIFICATION NAMEPLATES AND LABELS

- A Identification Nameplates:
  - 1. Materials:
    - a. Indoor Clean, Dry Locations: Use plastic nameplates.
    - b. Outdoor Locations: Use plastic nameplates suitable for exterior use.
  - 2. Plastic Nameplates: Two-layer or three-layer laminated electrically non-conductive phenolic with beveled edges; minimum thickness of 1/16 inch; engraved text.
  - 3. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch high; Four, located at corners for larger sizes.
  - 4. Nameplates shall be secured with self tapping stainless steel screws; if screws have sharp ends they shall be protected, otherwise rivets shall be used.
- B Identification Labels:
  - 1. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.
    - a. Use only for indoor locations.
  - 2. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text.
- C Format for Equipment Identification:
  - 1. Minimum Size: 1 inch by 2.5 inches.
  - 2. Text: All capitalized unless otherwise indicated.
  - 3. Minimum Text Height:
    - a. Equipment Designation: 1/2 inch.
    - b. Exception: Provide minimum text height of 1 inch for equipment located more than 10 feet above floor or working platform.
- D Wiring device circuit labels.
  - 1. All wiring devices (receptacles and switches) shall be labeled with the circuit serving the device. Label shall be a typed adhesive label affixed to the front of the wiring device face plate. Label shall have black text on clear background.

## 2.03 UNDERGROUND WARNING TAPE

- A Foil-backed Detectable Type Tape: 3 inches wide, with minimum thickness of 7 mil, unless otherwise required for proper detection.
- B Legend: Type of service, continuously repeated over full length of tape.
- C Color:
  - 1. Tape for Buried Power Lines: Black text on red background.
  - 2. Tape for Buried Communication, Alarm, and Signal Lines: Black text on orange background.

## 2.04 WARNING SIGNS AND LABELS

- A Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.
- B Warning Signs:
  - 1. Materials:
    - a. Indoor Dry, Clean Locations: Use factory pre-printed rigid plastic or self-adhesive vinyl signs.
    - b. Outdoor Locations: Use factory pre-printed rigid aluminum signs.
  - 2. Rigid Signs: Provide four mounting holes at corners for mechanical fasteners.
- 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.

## 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.
- 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.
- E Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.
- F Install underground warning tape above buried lines with one tape per trench at six to eight inches below finished grade.
- G Secure rigid signs using stainless steel screws.
- H Mark all handwritten text, where permitted, to be neat and legible.

**3.03 FIELD QUALITY CONTROL**

- A Replace self-adhesive labels and markers that exhibit bubbles, wrinkles, curling or other signs of improper adhesion.

**END OF SECTION 26 05 53**

**SECTION 26 05 70**  
**ELECTRICAL COORDINATION DRAWINGS**

**1.01 SECTION INCLUDES**

- A The Electrical Contractor shall be responsible for providing 1/4 scale drawings to the Mechanical Contractor, in REVIT, for the entire project.
- B The drawings shall cover above ceiling spaces, mechanical rooms, electrical rooms, and service yards.

**PART 2 PRODUCT - NOT USED**

**PART 3 EXECUTION**

**3.01 COORDINATION (REVIT)**

- A The Electrical contractor shall obtain architectural base plans from the architect. The drawings will be Revit **2018** or higher.
- B The drawing files shall be forwarded to the mechanical contractor for incorporation into the overall coordination drawings.
- C The Electrical contractor shall be responsible for coordinating any conflicts with the mechanical contractor and fire protection contractor. In addition, the electrical contractor is responsible for attending any required coordination meetings at the job site.
- D The final overall coordination drawings must be completed prior to any fire protection, mechanical and electrical work starting on the job.
- E The Electrical Contractor is responsible for purchasing his final overall coordination drawings from the printer.

**END OF SECTION 26 05 70 26 05 70**

**SECTION 26 05 73**  
**POWER SYSTEM STUDIES**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A Short-circuit study.
- B Protective device coordination study.
- C Arc flash and shock risk assessment.
  - 1. Includes arc flash hazard warning labels.
- D Criteria for the selection and adjustment of equipment and associated protective devices not specified in this section, as determined by studies to be performed.

**1.02 REFERENCE STANDARDS**

- A IEEE 1584 - IEEE Guide for Performing Arc-Flash Hazard Calculations; 2018, with Errata (2019).
- B NFPA 70 - National Electrical Code; National Fire Protection Association, Including All Applicable Amendments and Supplements; 2020.
- C NFPA 70E - Standard for Electrical Safety in the Workplace; 2018.

**1.03 ADMINISTRATIVE REQUIREMENTS**

- A Coordination:
  - 1. Coordinate the work to provide equipment and associated protective devices complying with criteria for selection and adjustment, as determined by studies to be performed.
  - 2. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.
- B Sequencing:
  - 1. Submit study reports prior to or concurrent with product submittals.
  - 2. Contractor shall be responsible for making any and all changes to the purchased equipment as recommended in the study results. Changes to the electrical distribution equipment, generator, transfer switches, and breakers due to study recommendations and to comply with the requirements of this section shall not incur an additional cost to the project. This includes but is not limited to changes in equipment or breakers to meet required maximum fault current levels, changes in breaker models, types or frame sizes to achieve selective coordination where required, changes in breaker models or types to achieve the required minimum AIC rating for transfer switches.
  - 3. Do not order equipment until matching study reports and product submittals have both been evaluated by Architect.
  - 4. Verify naming convention for equipment identification prior to creation of final drawings, reports, and arc flash hazard warning labels to match equipment name plates.
  - 5. Study shall be updated prior to project completion. All changes throughout construction shall be incorporated in the update.
  - 6. After study has been updated with construction changes, print and apply labels.
  - 7. Final study shall be included in the O&M manuals.

**1.04 SUBMITTALS**

- A Study preparer's qualifications.
- B Study reports, stamped or sealed and signed by study preparer.
- C Product Data:
  - 1. Include characteristic time-current trip curves for protective devices.
  - 2. Clearly indicate short circuit current ratings for all equipment. Series rating is not allowed.
- D All submittals transmitted to the engineer for approval shall have a digital copy of the report and model files included on a USB drive.
- E Arc Flash Hazard Warning Label Samples: One of each type required. All labels shall be rated to withstand the environment where installed.
- F Certification that field adjustable protective devices have been set in accordance with requirements of studies.
- G Project Record Documents: Revise studies as required to reflect as-built conditions.
  - 1. Include hard copies with operation and maintenance data submittals.

2. Include computer software files used to prepare studies with file name(s) cross-referenced to specific pieces of equipment and systems.

### 1.05 POWER SYSTEM STUDIES

#### A Scope of Studies:

1. Perform analysis of new electrical distribution system as indicated on drawings.
2. Except where study descriptions below indicate exclusions, analyze system at each bus from primary protective devices of utility source down to each piece of equipment involved, including parts of system affecting calculations being performed (e.g. fault current contribution from motors).
3. Include in analysis alternate sources and operating modes (including known future configurations) to determine worst case conditions.
  - a. Known Operating Modes:
    - 1) Utility as source.

#### B General Study Requirements:

1. Perform studies utilizing computer software complying with specified requirements; manual calculations are not permitted.

#### C Data Collection:

1. Compile information on project-specific characteristics of actual installed equipment, protective devices, feeders, etc. as necessary to develop single-line diagram of electrical distribution system and associated input data for use in system modeling.
  - a. Utility Source Data: Include primary voltage, maximum and minimum three-phase and line-to-ground fault currents, impedance, X/R ratio, and primary protective device information.
    - 1) Obtain up-to-date information from Utility Company.
    - 2) Include in the report documentation the following information
      - (a) Utility Company: Contractor to Determine.
        - (1) Point of Contact: Contractor to Determine.
        - (2) Address: Contractor to Determine.
        - (3) Phone: Contractor to Determine.
        - (4) Email: Contractor to Determine.
        - (5) Utility Company Project Reference Number: Contractor to Determine.
        - (6) Date Fault Current was obtained from power company.
  - b. Generators: Include manufacturer/model, kW and voltage ratings, and impedance.
  - c. Motors 25HP and greater: Include manufacturer/model, type (e.g. induction, synchronous), horsepower rating, voltage rating, and full load amps.
  - d. Branch circuit and overcurrent protective device information associated with all industrial control panels, including HVAC control panels.
  - e. Transformers: Include primary and secondary voltage ratings, kVA rating, winding configuration, percent impedance, and X/R ratio.
  - f. Protective Devices:
    - 1) Circuit Breakers: Include manufacturer/model, type (e.g. thermal magnetic, electronic trip), frame size, trip rating, voltage rating, interrupting rating, available field-adjustable trip response settings, and features (e.g. zone selective interlocking).
    - 2) Fuses: Include manufacturer/model, type/class (e.g. Class J), size/rating, and speed (e.g. time delay, fast acting).
  - g. Conductors: Include feeder size, material (e.g. copper, aluminum), insulation type, voltage rating, number per phase, raceway type, and actual length.
  - h. Contractor shall maintain a log of all conductor sizes and lengths to be used in the power systems study.

#### D Short-Circuit Study:

1. For purposes of determining equipment short circuit current ratings, consider conditions that may result in maximum available fault current, including but not limited to:
  - a. Maximum utility fault currents.
  - b. Maximum motor contribution.

2. For each bus location, calculate the maximum available three-phase bolted symmetrical and asymmetrical fault currents. For grounded systems, also calculate the maximum available line-to-ground bolted fault currents.
  3. Calculate the short circuit current at the following additional locations:
    - a. Elevator Controllers.
    - b. Industrial Control Panels, including HVAC control panels.
    - c. Motor Control Centers.
- E Protective Device Coordination Study:
1. Analyze alternate scenarios considering known operating modes (e.g. utility as source, generator as source).
  2. Analyze protective devices on the normal power system and associated settings for suitable margins between time-current curves to achieve best possible coordination while providing adequate protection for equipment and conductors.
  3. For emergency systems analyze protective devices and associated settings so that full selective coordination is achieved per NEC 700.27
- F Arc Flash and Shock Risk Assessment:
1. Comply with NFPA 70E.
  2. Perform incident energy and arc flash boundary calculations in accordance with IEEE 1584 (as referenced in NFPA 70E Annex D), where applicable.
  3. Analyze alternate scenarios considering conditions that may result in maximum incident energy, including but not limited to:
    - a. Maximum and minimum utility fault currents.
    - b. Maximum and minimum motor contribution.
    - c. Known operating modes (e.g. utility as source, generator as source).
- G Study Reports:
1. General Requirements:
    - a. Identify date of study and study preparer.
    - b. Identify study methodology and software product(s) used.
    - c. Identify scope of studies, assumptions made, implications of possible alternate scenarios, and any exclusions from studies.
    - d. Include single-line diagram and associated input data used for studies; identify buses on single-line diagram as referenced in reports, and indicate bus voltage.
    - e. Include conclusions and recommendations.
  2. Short-Circuit Study:
    - a. For each scenario, identify at each bus location:
      - 1) Calculated maximum available symmetrical and asymmetrical fault currents (both three-phase and line-to-ground where applicable).
      - 2) Fault point X/R ratio.
      - 3) Associated equipment short circuit current ratings.
    - b. Identify locations where the available fault current exceeds the equipment short circuit current rating, along with recommendations.
  3. Protective Device Coordination Study:
    - a. For each scenario, include time-current coordination curves plotted on log-log scale graphs.
    - b. For each graph include (where applicable):
      - 1) Partial single-line diagram identifying the portion of the system illustrated.
      - 2) Protective Devices: Time-current curves with applicable tolerance bands for each protective device in series back to the source, plotted up to the maximum available fault current at the associated bus.
      - 3) Transformers: Inrush points and damage curves.
      - 4) Generators: Full load current, overload curves, decrement curves, and short circuit withstand points.
      - 5) Motors: Full load current, starting curves, and damage curves.

- c. For each protective device, identify fixed and adjustable characteristics with available ranges and recommended settings.
    - 1) Circuit Breakers: Include long time pickup and delay, short time pickup and delay, and instantaneous pickup.
    - 2) Include ground fault pickup and delay.
    - 3) Include fuse ratings.
  - d. Identify cases where either full selective coordination or adequate protection is not achieved, along with recommendations.
4. Arc Flash and Shock Risk Assessment:
- a. For the worst case for each scenario, identify at each bus location:
    - 1) Calculated incident energy and associated working distance.
    - 2) Calculated arc flash boundary.
    - 3) Bolted fault current.
    - 4) Arcing fault current.
    - 5) Clearing time.
    - 6) Arc gap distance.
  - b. For purposes of producing arc flash hazard warning labels, summarize the maximum incident energy and associated data reflecting the worst case condition of all scenarios at each bus location.
  - c. Include recommendations for reducing the incident energy at locations where the calculated maximum incident energy exceeds 8 calories per sq cm.
5. For One-line diagram indicate the following:
- a. At each Bus:
    - 1) Equipment ID.
    - 2) Voltage.
    - 3) 3 Phase Fault Current.
    - 4) 1 Phase Fault Current.
    - 5) X/R ratio.
  - b. At each breaker:
    - 1) Equipment ID.
    - 2) Device Amperage.
    - 3) Voltage Rating.
    - 4) Interrupting Rating.
    - 5) Breaker Settings (If applicable).
  - c. At each source:
    - 1) Device ID.
    - 2) Voltage.
    - 3) 3 Phase Fault Current.
    - 4) 1 Phase Fault Current.
    - 5) X/R Rating.
  - d. At each Generator:
    - 1) Equipment ID.
    - 2) Rated kW.
    - 3) Rated kVA.
    - 4) Voltage.
  - e. At each Transformer:
    - 1) Equipment ID.
    - 2) Rated kVA.
    - 3) Primary Voltage.
    - 4) Secondary Voltage.
    - 5) Percent Impedance.
  - f. At each Motor:

- 1) Equipment ID.
- 2) Rated Horse Power.

### 1.06 QUALITY ASSURANCE

- A Study Preparer Qualifications: Professional electrical engineer licensed in the State in which the Project is located and with minimum three years experience in the preparation of studies of similar type and complexity using specified computer software.
  1. Study preparer may be employed by the manufacturer of the electrical distribution equipment.
- B Computer Software for Study Preparation: Use the latest edition of commercially available software utilizing specified methodologies.
  1. Acceptable Software Products:
    - a. EasyPower LLC: [www.easypower.com/#sle](http://www.easypower.com/#sle).
    - b. ETAP/Operation Technology, Inc: [www.etap.com/#sle](http://www.etap.com/#sle).
    - c. SKM Systems Analysis, Inc: [www.skm.com/#sle](http://www.skm.com/#sle).

## PART 2 PRODUCTS

### 2.01 ARC FLASH HAZARD WARNING LABELS

- A Provide warning labels complying with ANSI Z535.4 to identify arc flash hazards for each work location analyzed by the arc flash and shock risk assessment.
  1. Materials: Label shall be vinyl adhesive with moisture and UV resistance. Paper adhesive labels will not be accepted.
  2. Label Information shall comply with 2015 NFPA 70E.
  3. Legend: Provide custom legend in accordance with NFPA 70E based on equipment-specific data as determined by arc flash and shock risk assessment.
    - a. Include at least the following information:
      - 1) Arc flash boundary.
      - 2) Available incident energy and corresponding working distance.
      - 3) Site-specific PPE (personnel protective equipment) requirements.
      - 4) Nominal system voltage.
      - 5) Limited approach boundary.
      - 6) Restricted approach boundary.
      - 7) Equipment identification.
      - 8) Date calculations were performed.

## PART 3 EXECUTION

### 3.01 INSTALLATION

- A Labels shall be cut with straight and perpendicular lines.
- B Labels shall be installed neatly and consistently from one piece of equipment to another.
- C Clean surface of equipment so that it is free of dirt, dust, or other foreign substance prior to applying labels.

### 3.02 FIELD QUALITY CONTROL

- A Adjust equipment and protective devices for compliance with studies and recommended settings.

**END OF SECTION 26 05 73**



**SECTION 26 09 23**  
**LIGHTING CONTROL DEVICES**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A Occupancy sensors.
- B Lighting contactors.
- C Accessories.

**1.02 REFERENCE STANDARDS**

- A NFPA 70 - National Electrical Code; National Fire Protection Association, Including All Applicable Amendments and Supplements; 2020.
- B NEMA ICS 2 - Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts; 2008 (Reaffirmed 2020).
- C NEMA ICS 5 - Industrial Control and Systems: Control Circuit and Pilot Devices; 2017.
- D NEMA ICS 6 - Industrial Control and Systems: Enclosures; 1993 (Reaffirmed 2016).
- E UL 60947-1 - Low-Voltage Switchgear and Controlgear - Part 1: General Rules; Current Edition, Including All Revisions.
- F UL 60947-4-1 - Low-Voltage Switchgear and Controlgear - Part 4-1: Contactors and Motor-starters - Electromechanical Contactors and Motor-starters; Current Edition, Including All Revisions.

**1.03 ADMINISTRATIVE REQUIREMENTS**

- A Coordination:
  - 1. Coordinate the placement of wall switch occupancy sensors with actual installed door swings.
  - 2. Coordinate the placement of occupancy sensors with millwork, furniture, equipment or other potential obstructions to motion detection coverage installed under other sections or by others.
  - 3. Notify Architect of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.
- B Sequencing:
  - 1. Do not install lighting control devices until final surface finishes and painting are complete.

**1.04 SUBMITTALS**

- A Product Data: Include ratings, configurations, standard wiring diagrams, dimensions, colors, service condition requirements, and installed features.
  - 1. Occupancy Sensors: Include detailed motion detection coverage range diagrams.
- B Shop Drawings:
  - 1. Occupancy Sensors: Provide lighting plan indicating location, model number, and orientation of each occupancy sensor and associated system component.
- C Field Quality Control Reports.
- D Manufacturer's Installation Instructions: Include application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- E Operation and Maintenance Data: Include detailed information on device programming and setup.
- F Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
- G Project Record Documents: Record actual installed locations and settings for lighting control devices.

**1.05 QUALITY ASSURANCE**

- A Comply with requirements of NFPA 70.
- B Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C Product Listing Organization Qualifications: Third party agencies shall be amongst those accredited by the NCBC (North Carolina Building Code Council) to label Electrical and Mechanical Equipment.

**1.06 DELIVERY, STORAGE, AND PROTECTION**

- A Store products in a clean, dry space in original manufacturer's packaging in accordance with manufacturer's written instructions until ready for installation.

**1.07 FIELD CONDITIONS**

- A Maintain field conditions within manufacturer's required service conditions during and after installation.

## 1.08 WARRANTY

- A Provide five year manufacturer warranty for all occupancy sensors.

## PART 2 PRODUCTS

### 2.01 LIGHTING CONTROL DEVICES - GENERAL REQUIREMENTS

- A Provide products listed, classified, and labeled as suitable for the purpose intended.
- B Unless specifically indicated to be excluded, provide all required conduit, wiring, connectors, hardware, components, accessories, etc. as required for a complete operating system.

### 2.02 OCCUPANCY SENSORS

- A Manufacturers:
1. Hubbell Incorporated: [www.hubbell.com/#sle](http://www.hubbell.com/#sle).
  2. Leviton.
  3. WattStopper.
  4. Approved Equal.
  5. Source Limitations: Furnish products produced by a single manufacturer and obtained from a single supplier.
- B All Occupancy Sensors:
1. Description: Factory-assembled commercial specification grade devices for indoor use capable of sensing both major motion, such as walking, and minor motion, such as small desktop level movements, according to published coverage areas, for automatic control of load indicated.
  2. Sensor Technology:
    - a. Passive Infrared (PIR) Occupancy Sensors: Designed to detect occupancy by sensing movement of thermal energy between zones.
    - b. Ultrasonic Occupancy Sensors: Designed to detect occupancy by sensing frequency shifts in emitted and reflected inaudible sound waves.
    - c. Passive Infrared/Ultrasonic Dual Technology Occupancy Sensors: Designed to detect occupancy using a combination of both passive infrared and ultrasonic technologies.
  3. Provide LED to visually indicate motion detection.
  4. Operation: Unless otherwise indicated, occupancy sensor to turn load on when occupant presence is detected and to turn load off when no occupant presence is detected during an adjustable turn-off delay time interval.
  5. Dual Technology Occupancy Sensors: Field configurable turn-on and hold-on activation with settings for activation by either or both sensing technologies.
  6. Passive Infrared Lens Field of View: Field customizable by addition of factory masking material, adjustment of integral blinders, or similar means to block motion detection in selected areas.
  7. Turn-Off Delay: Field adjustable, with time delay settings up to 30 minutes.
  8. Sensitivity: Field adjustable.
  9. Adaptive Technology: Field selectable; capable of self-adjusting sensitivity and time delay according to conditions.
  10. Isolated Relay for Low Voltage Occupancy Sensors: SPDT dry contacts, for interface with HVAC systems.
- C Wall Switch Occupancy Sensors:
1. All Wall Switch Occupancy Sensors:
    - a. Description: Occupancy sensors designed for installation in standard wall box at standard wall switch mounting height with a field of view of 180 degrees, integrated manual control capability, and no leakage current to load in off mode.
    - b. Unless otherwise indicated or required to control the load indicated on drawings, provide line voltage units with self-contained relay.
    - c. Finish: Match finishes specified for wiring devices in Section 26 27 26, unless otherwise indicated.
  2. Dual Technology wall switch occupancy sensors: Capable of detecting motion within an area of 35 x 30 foot area for major motion and a 20 x 15 foot area for minor motion.
    - a. Products:

- 1) Single Button: Wattstopper DW-100.
  - 2) Two Button: Wattstopper DW-200.
  - 3) or approved equal.
- D Ceiling Mounted Occupancy Sensors:
1. All Ceiling Mounted Occupancy Sensors:
    - a. Description: Low profile occupancy sensors designed for ceiling installation.
    - b. Unless otherwise indicated or required to control the load indicated on drawings, provide low voltage units, for use with separate compatible accessory power packs.
    - c. Provide field selectable setting for disabling LED motion detector visual indicator.
    - d. Occupancy sensor to be field selectable as either manual-on/automatic-off or automatic on/off.
    - e. Finish: White unless otherwise indicated.
  2. Passive Infrared (PIR) Ceiling Mounted Occupancy Sensors:
    - a. Standard Range Sensors: Capable of detecting motion within an area of 500 square feet coverage at a mounting height of 8 feet, with a field of view of 360 degrees.
      - 1) Products:
        - (a) Wattstopper CI-200-1.
        - (b) Approved Equal.
      - b. Extended Range Sensors: Capable of detecting motion within an area of 2,000 square feet coverage at a mounting height of 15 feet, with a field of view of 360 degrees.
        - 1) Products:
          - (a) Wattstopper CX-100.
          - (b) or approved equal.
    3. Ultrasonic Ceiling Mounted Occupancy Sensors:
      - a. Extended Range Sensors: Capable of detecting motion within an area of 1,100 square feet coverage at a mounting height of 12 feet, with a field of view of 360 degrees.
        - 1) Products:
          - (a) Room Sensors: Wattstopper WT1100.
          - (b) Corridor Sensor with 90 linear feet of coverage Wattstopper WT 2250.
          - (c) or approved equal.
      4. Passive Infrared/Ultrasonic Dual Technology Ceiling Mounted Occupancy Sensors:
        - a. Extended Range Sensors: Capable of detecting motion within an area of 1,000 square feet coverage 9 feet, with a field of view of 360 degrees.
          - 1) Products:
            - (a) Wattstopper DT-300.

E Directional Occupancy Sensors:

    1. All Directional Occupancy Sensors: Designed for wall or ceiling mounting, with integral swivel for field adjustment of motion detection coverage.
      - a. Unless otherwise indicated or required to control the load indicated on drawings, provide low voltage units, for use with separate compatible accessory power packs.
      - b. Provide field selectable setting for disabling LED motion detector visual indicator.
      - c. Finish: White unless otherwise indicated.
    2. Passive Infrared (PIR) Directional Occupancy Sensors:
    3. Passive Infrared/Ultrasonic Dual Technology Directional Occupancy Sensors: Capable of detecting motion within a distance of 40 feet at a mounting height of 10 feet.
      - a. Products:
        - 1) Wattstopper CX-100.
        - 2) Wattstopper DT-200.
        - 3) or approved equal.
- F Power Packs for Low Voltage Occupancy Sensors:
1. Description: Plenum rated, self-contained low voltage class 2 transformer and relay compatible with specified low voltage occupancy sensors for switching of line voltage loads.

2. Provide quantity and configuration of power and slave packs with all associated wiring and accessories as required to control the load indicated on drawings.
3. Input Supply Voltage: Dual rated for 120/277 V ac.
4. Power packs shall be capable of fitting in a standard 4" square junction box.
5. Load Rating: As required to control the load indicated on drawings.
6. Provide isolated relay for interface with HVAC units.

### 2.03 LIGHTING CONTACTORS

- A Manufacturers:
1. ABB/GE: [www.geindustrial.com/#sle](http://www.geindustrial.com/#sle).
  2. Eaton Corporation: [www.eaton.com/#sle](http://www.eaton.com/#sle).
  3. Schneider Electric; Square D Products: [www.schneider-electric.us/#sle](http://www.schneider-electric.us/#sle).
- B Description: Magnetic lighting contactors complying with NEMA ICS 2, and listed and labeled as complying with UL 60947-1 and UL 60947-4-1; noncombination type unless otherwise indicated; ratings, configurations and features as indicated on the drawings.
- C Short Circuit Current Rating:
1. Provide contactors with listed short circuit current rating not less than the available fault current at the installed location as determined by short circuit study performed in accordance with Section 26 05 73.
- D Enclosures:
1. Comply with NEMA ICS 6.
  2. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
  3. Finish: Manufacturer's standard unless otherwise indicated.

### 2.04 ACCESSORIES

- A Auxiliary Contacts:
1. Comply with NEMA ICS 5.
  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 lighting contactor, minimum.
- B Pilot Devices:
1. Comply with NEMA ICS 5; heavy-duty type.
  2. Selector Switches: Unless otherwise indicated, provide maintained, non-illuminated type with knob operator; number of switch positions as indicated or as required.
  3. Indicating Lights: Push-to-test type unless otherwise indicated.

### 2.05 LIGHTING OVERRIDE SWITCHES AND BAS PROGRAMMING

- A Coordinate all override lighting controls, contactors, and programming with the BAS controls contractor.
- B BAS controls contractor shall provide single button override switches with all associated wiring back to BAS panel. Electrical contractor shall provide device box, and 3/4" conduit, with pull string, to above nearest accessible ceiling.
- C BAS system will have all required outputs to control the lighting contactors identified on the drawings.
- D Override switches shall be programmed by BAS controls contractor as follows:
1. Time of day schedule shall be coordinated with owner.
  2. During scheduled on period: button press has no effect.
  3. Impending off event: Fifteen minutes prior to a scheduled off event BAS shall blink the lights on and off three times in three second intervals to warn occupants.
  4. If button is pressed during an impending off event the normal schedule shall be overridden to be on for two hours from the time the button is pressed.
  5. 15 minutes prior to the 2 hour override is expired if the normal schedule is still off another impending off blink warning will be initiated.
  6. Pressing the button at any time during a normally scheduled off period will initiate a 2 hour on override.
- E Exterior Lighting Controls Programming.
1. Exterior lighting schedule shall be confirmed with owner prior to programming.

2. On/Off schedule shall be adjustable based on daylight sensor input to turn exterior lighting on/off based on exterior lighting levels.
  3. In general exterior lighting shall turn on 15 minutes prior to sunset, off at 12:00am, and on again at 5:00 am until sunrise. Coordinate final sequence with owner.
- F Upon activation of fire alarm system the BAS shall automatically override any schedule off period or event. Normal programmed schedule to resume once fire alarm system is no longer in alarm.

### **PART 3 EXECUTION**

#### **3.01 EXAMINATION**

- A Verify that field measurements are as indicated.
- B Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.
- C Verify that openings for outlet boxes are neatly cut and will be completely covered by devices or wall plates.
- D Verify that final surface finishes are complete, including painting.
- E Verify that branch circuit wiring installation is completed, tested, and ready for connection to lighting control devices.
- F Verify that the service voltage and ratings of lighting control devices are appropriate for the service voltage and load requirements at the location to be installed.
- G Verify that conditions are satisfactory for installation prior to starting work.

#### **3.02 PREPARATION**

- A Provide extension rings to bring outlet boxes flush with finished surface.
- B Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

#### **3.03 INSTALLATION**

- A Perform work in a neat and workmanlike manner in accordance.
- B Coordinate locations of outlet boxes provided under Section 26 05 33.16 as required for installation of lighting control devices provided under this section.
  1. Mounting Heights: Unless otherwise indicated, as follows:
    - a. Wall Switch Occupancy Sensors: 48 inches above finished floor.
  2. Orient outlet boxes for vertical installation of lighting control devices unless otherwise indicated.
- C Install lighting control devices in accordance with manufacturer's instructions.
- D Unless otherwise indicated, connect lighting control device grounding terminal or conductor to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
- E Install lighting control devices plumb and level, and held securely in place.
- F Where required and not furnished with lighting control device, provide wall plate in accordance with Section 26 27 26.
- G Provide required supports in accordance with Section 26 05 29.
- H Where applicable, install lighting control devices and associated wall plates to fit completely flush to mounting surface with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings.
- I Occupancy Sensor Locations:
  1. Location Adjustments: Locations indicated are diagrammatic and only intended to indicate which rooms or areas require devices. Provide quantity and locations as required for complete coverage of respective room or area based on manufacturer's recommendations for installed devices.
  2. Locate ultrasonic and dual technology passive infrared/ultrasonic occupancy sensors a minimum of 6 feet from air supply ducts or other sources of heavy air flow and as per manufacturer's recommendations, in order to minimize false triggers.
- J Unless otherwise indicated, install power packs for lighting control devices above accessible ceiling near the sensor location.
- K Unless otherwise indicated, install switches on load side of power packs so that switch does not turn off power pack.

#### **3.04 FIELD QUALITY CONTROL**

- A Provide System Commissioning in accordance with 2018 NCECC Section C408.
- B Inspect each lighting control device for damage and defects.

- C Test occupancy sensors to verify proper operation, including time delays and ambient light thresholds where applicable. Verify optimal coverage for entire room or area.
- D Correct wiring deficiencies and replace damaged or defective lighting control devices.

**3.05 ADJUSTING**

- A Adjust devices and wall plates to be flush and level.
- B Adjust occupancy sensor settings to minimize undesired activations while optimizing energy savings, and to achieve desired function as indicated or as directed by Architect.
- C Adjust position of directional occupancy sensors and outdoor motion sensors to achieve optimal coverage as required.
- D Where indicated or as directed by Architect or owner, install factory masking material or adjust integral blinders on passive infrared (PIR) and dual technology occupancy sensor lenses to block undesired motion detection.
- E Adjust time switch settings to achieve desired operation schedule as indicated or as directed by Architect.

**3.06 CLEANING**

- A Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

**3.07 CLOSEOUT ACTIVITIES**

- A Demonstration: Demonstrate proper operation of lighting control devices to Architect, and correct deficiencies or make adjustments as directed.
- B Training: Train Owner's personnel on operation, adjustment, programming, and maintenance of lighting control devices.
  - 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: Qualified contractor familiar with the project and with sufficient knowledge of the installed lighting control devices.
  - 4. Location: At project site.

**END OF SECTION 26 09 23**

**SECTION 26 24 16**  
**PANELBOARDS**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A Power distribution panelboards.
- B Lighting and appliance panelboards.
- C Overcurrent protective devices for panelboards.

**1.02 REFERENCE STANDARDS**

- A UL 67 - Panelboards; Current Edition, Including All Revisions.
- B UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.
- C NFPA 70 - National Electrical Code; National Fire Protection Association, Including All Applicable Amendments and Supplements; 2020.

**1.03 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 the work with other trades to provide walls suitable for installation of flush-mounted panelboards where indicated.
  - 4. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
  - 5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

**1.04 SUBMITTALS**

- A Product Data: Provide manufacturer's standard catalog pages and data sheets for panelboards, enclosures, overcurrent protective devices, and other installed components and accessories.
  - 1. Contractor shall confirm that all lug sizes and quantities submitted are compatible with the conductors specified on the contract documents. Changes required to lug sizes and quantities due to lack of coordination between the contractor and the supplier are to be made at the contractor's expense.
- B Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
  - 1. It is the contractor's responsibility to ensure that the equipment submitted to comply with the requirements of this section are in compliance with the requirements and recommendations of the power system studies. Any changes recommended by the power system study shall be incorporated at no expense to the project.
- C Field Quality Control Test Reports.
- D Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- E Project Record Documents: Record actual installed locations of panelboards and actual installed circuiting arrangements.
- F Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

**1.05 QUALITY ASSURANCE**

- A Comply with requirements of NFPA 70.
- B Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C Product Listing Organization Qualifications: Third party agencies shall be amongst those accredited by the NCBC (North Carolina Building Code Council) to label Electrical and Mechanical Equipment.

- D Contractor shall schedule a pre-energization site visit with the Engineer. Meeting shall be scheduled at least 7 days in advance. The results of the megger test and service ground resistance test shall be made available to the Engineer prior to scheduling the pre-energization site visit.

**1.06 DELIVERY, STORAGE, AND HANDLING**

- A Receive, inspect, handle, and store panelboards in accordance with manufacturer's instructions.
- B 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.
- C Handle carefully in accordance with manufacturer's written instructions to avoid damage to panelboard internal components, enclosure, and finish.

**1.07 FIELD CONDITIONS**

- A Maintain ambient temperature within the following limits during and after installation of panelboards:
  - 1. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.

**PART 2 PRODUCTS**

**2.01 MANUFACTURERS**

- A ABB/GE: [www.geindustrial.com/#sle](http://www.geindustrial.com/#sle).
- B Eaton Corporation.
- C Schneider Electric; Square D Products.
- D Source Limitations: Furnish panelboards and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

**2.02 PANELBOARDS - GENERAL REQUIREMENTS**

- A Provide products listed, classified, and labeled as suitable for the purpose intended.
- B Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
  - 1. Altitude: Less than 6,600 feet.
  - 2. Ambient Temperature:
    - a. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.
- C Short Circuit Current Rating:
  - 1. Provide panelboards with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.
  - 2. When a power system study is included in the contract short circuit current ratings shall be verified with the study prior to submitting equipment for approval. Any changes required to meet the maximum available fault current shall be made in the submittal.
  - 3. Series rating is not allowed.
- D Panelboards Used for Service Entrance: Listed and labeled as suitable for use as service equipment according to UL 869A.
- E Service Entrance Panelboards shall have Main Circuit Breaker 100% fully rated.
- F Mains: Configure for top or bottom incoming feed as indicated or as required for the installation.
- G Branch Overcurrent Protective Devices: Replaceable without disturbing adjacent devices.
- H Bussing: Sized in accordance with UL 67 temperature rise requirements.
  - 1. Provide fully rated neutral bus unless otherwise indicated, with a suitable lug for each feeder or branch circuit requiring a neutral connection.
  - 2. Provide solidly bonded equipment ground bus in each panelboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.
- I Conductor Terminations: Suitable for use with the conductors to be installed.
- J Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
  - 1. Environment Type per NEMA 250: As indicated on the drawings.
  - 2. Boxes: Galvanized steel unless otherwise indicated.
  - 3. Fronts:
    - a. Fronts for Surface-Mounted Enclosures: Same dimensions as boxes.
    - b. Fronts for Flush-Mounted Enclosures: Overlap boxes on all sides to conceal rough opening.
    - c. All covers shall be door in door type where one door can be opened to access the breakers and and dead front and the second door opens to the wire bending space adjacent to the dead front.



- d. Door in door covers shall feature a full length piano hinge.
- 4. Lockable Doors: All locks keyed alike unless otherwise indicated.
- K Future Provisions: Prepare all unused spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.
- L Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.
- M Load centers are not acceptable.

### 2.03 POWER DISTRIBUTION PANELBOARDS

- A Description: Panelboards complying with NEMA PB 1, power and feeder distribution type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.
- B Conductor Terminations:
  - 1. Main and Neutral Lug Material: Copper, suitable for terminating copper conductors only.
  - 2. Main and Neutral Lug Type: Compression.
- C Bussing:
  - 1. Phase and Neutral Bus Material: Copper.
  - 2. Ground Bus Material: Copper.
- D Circuit Breakers:
  - 1. Provide bolt-on type.
  - 2. Provide thermal magnetic circuit breakers for circuit breaker frame sizes less than 250 amperes.
  - 3. Provide electronic trip circuit breakers for circuit breaker frame sizes 250 amperes and above.
- E Enclosures:
  - 1. Fronts: Provide door-in-door trim with hinged cover for access to load terminals and wiring gutters, and separate lockable hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.
  - 2. Provide clear plastic circuit directory holder mounted on inside of door.

### 2.04 LIGHTING AND APPLIANCE PANELBOARDS

- A Description: Panelboards complying with NEMA PB 1, lighting and appliance branch circuit type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.
- B Conductor Terminations:
  - 1. Main and Neutral Lug Material: Copper, suitable for terminating copper conductors only.
  - 2. Main and Neutral Lug Type: Compression.
- C Bussing:
  - 1. Phase Bus Connections: Arranged for sequential phasing of overcurrent protective devices.
  - 2. Phase and Neutral Bus Material: Copper.
  - 3. Ground Bus Material: Copper.
- D Circuit Breakers: Thermal magnetic bolt-on type unless otherwise indicated.
- E Provide electronic trip circuit breakers for circuit breaker frame sizes [250] amperes and above.
- F Enclosures:
  - 1. Fronts: Provide door-in-door trim with hinged cover for access to load terminals and wiring gutters, and separate lockable hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.
  - 2. Provide clear plastic circuit directory holder mounted on inside of door.

### 2.05 OVERCURRENT PROTECTIVE DEVICES

- A Main Breaker for Service Entrance Equipment shall be 100% Fully Rated!
- B Molded Case Circuit Breakers:
  - 1. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
  - 2. Interrupting Capacity:

- a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated.
- b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
3. Conductor Terminations:
  - a. Provide compression lugs.
  - b. Lug Material: Copper, suitable for terminating copper conductors only.
4. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
  - a. Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 100 amperes and larger.
5. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.
6. Provide electronic trip circuit breakers for circuit breaker frame sizes larger than 250 amperes.
  - a. Provide the following individually field-adjustable trip response settings:
    - 1) Long time pickup, adjustable by setting dial.
    - 2) Long time delay.
    - 3) Short time pickup and delay.
    - 4) Instantaneous pickup.
    - 5) Ground fault pickup and delay where ground fault protection is indicated.
7. Do not use handle ties in lieu of multi-pole circuit breakers.
8. Provide multi-pole circuit breakers for multi-wire branch circuits as required by NFPA 70.
9. Provide the following features and accessories where indicated or where required to complete installation:
  - a. Shunt Trip: Provide coil voltage as required for connection to indicated trip actuator.
  - b. Handle Pad-Lock Provision: For locking circuit breaker handle in OFF position.
    - 1) Provide handle locks for all breakers serving fire alarm equipment or elevator emergency communication systems. Handle locks shall be Space Age Electronics ELOCK series or approved equal.

### **PART 3 EXECUTION**

#### **3.01 EXAMINATION**

- A Verify that field measurements are as indicated.
- B Verify that the ratings and configurations of the panelboards and associated components are consistent with the indicated requirements.
- C Verify that mounting surfaces are ready to receive panelboards.
- D Verify that conditions are satisfactory for installation prior to starting work.

#### **3.02 INSTALLATION**

- A Perform work in accordance with NECA 1 (general workmanship).
- B Install products in accordance with manufacturer's instructions.
- C Install panelboards securely, in a neat and workmanlike manner.
- D Arrange equipment to provide at least clearances in accordance with manufacturer's instructions and NFPA 70.
- E Provide required support and attachment in accordance with Section 26 05 29.
- F Install panelboards plumb.
- G Mount panelboards such that the highest position of any operating handle for circuit breakers or switches does not exceed 79 inches above the floor or working platform.
- H Provide grounding and bonding in accordance with Section 26 05 26.
- I Install all field-installed branch devices, components, and accessories.
- J Set field-adjustable circuit breaker tripping function settings as directed. If a power system study is included in the contract, set breakers according to the recommendations made in the study.
- K Provide filler plates to cover unused spaces in panelboards.

- L Provide circuit breaker lock-on devices to prevent unauthorized personnel from de-energizing essential loads where indicated. Also provide for the following:
  - 1. Emergency and night lighting circuits.
  - 2. Fire detection and alarm circuits.
- M Identify panelboards in accordance with Section 26 05 53.

### 3.03 FIELD QUALITY CONTROL

- A Molded Case Circuit Breakers: Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for all main circuit breakers and circuit breakers larger than 600 amperes. Tests listed as optional are not required.
  - 1. Verify equipment nameplate is in accordance with contract documents.
  - 2. Inspect physical and mechanical condition.
  - 3. Inspect anchorage and alignment.
  - 4. Verify unit is clean.
  - 5. Operate breaker to ensure smooth operation.
  - 6. Perform breaker adjustments in accordance with the power system study.
  - 7. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
  - 8. Perform insulation-resistance test for one minute on each pole, phase-to-phase and phase-to-ground with circuit breaker closed.
  - 9. Perform contact/pole resistance test.
  - 10. Determine long-time and short time pickup and delay settings by primary current injection.
  - 11. Determine ground fault pickup and time delay by primary current injection.
- B Ground Fault Protection Systems: Test in accordance with manufacturer's instructions as required by NFPA 70.
- C Test GFCI circuit breakers to verify proper operation.
- D Test shunt trips to verify proper operation.
- E Correct deficiencies and replace damaged or defective panelboards or associated components.
- F For Services and feeders 1000 amperes and larger, and any installation utilizing selective coordination, the following test should be performed on the circuit breakers. Testing shall be performed by a qualified manufacturer's factory technician at the job site. All readings shall be tabulated.
  - 1. Phase Tripping tolerance (within 20% of UL requirements).
  - 2. Trip time (per phase) in seconds.
  - 3. Instantaneous trip (amps) per phase.
  - 4. Insulation resistance (in megohms) at 1000-volts DC (phase to phase, and line to load).

### 3.04 ADJUSTING

- A Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.
- B Adjust alignment of panelboard fronts.
- C Load Balancing: For each panelboard, rearrange circuits such that the difference between each measured steady state phase load does not exceed 20 percent and adjust circuit directories accordingly. Maintain proper phasing for multi-wire branch circuits.

### 3.05 CLEANING

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

**END OF SECTION 26 24 16**

**SECTION 26 27 26**  
**WIRING DEVICES**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A Wall switches.
- B Wall dimmers.
- C Receptacles.
- D Wall plates.

**1.02 REFERENCE STANDARDS**

- A UL 20 - General-Use Snap Switches; Current Edition, Including All Revisions.
- B UL 498 - Attachment Plugs and Receptacles; Current Edition, Including All Revisions.
- C UL 514D - Cover Plates for Flush-Mounted Wiring Devices; Current Edition, Including All Revisions.
- D UL 1472 - Solid-State Dimming Controls; Current Edition, Including All Revisions.
- E NFPA 70 - National Electrical Code; National Fire Protection Association, Including All Applicable Amendments and Supplements; 2020.

**1.03 ADMINISTRATIVE REQUIREMENTS**

- A Coordination:
  - 1. Coordinate the placement of outlet boxes with millwork, furniture, equipment, etc. installed under other sections or by others.
  - 2. Coordinate wiring device ratings and configurations with the electrical requirements of actual equipment to be installed.
  - 3. Coordinate the placement of outlet boxes for wall switches with actual installed door swings.
  - 4. Coordinate the installation and preparation of uneven surfaces, such as split face block, to provide suitable surface for installation of wiring devices.
  - 5. Notify Architect of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.
- B Sequencing:
  - 1. Do not install wiring devices until final surface finishes and painting are complete.

**1.04 SUBMITTALS**

- A Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.
  - 1. Wall Dimmers: Include derating information for ganged multiple devices.
- B Certificates for Surge Protection Receptacles: Manufacturer's documentation of listing for compliance with UL 1449.
- C Field Quality Control Test Reports.
- D Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- E Operation and Maintenance Data:
  - 1. Wall Dimmers: Include information on operation and setting of presets.
  - 2. GFCI Receptacles: Include information on status indicators.
- F Project Record Documents: Record actual installed locations of wiring devices.
- G Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
  - 1. Screwdrivers for Tamper-Resistant Screws: Two for each type of screw.
  - 2. Extra Keys for Locking Switches: Two of each type.
  - 3. Extra Wall Plates: Two of each style, size, and finish.

**1.05 QUALITY ASSURANCE**

- A Comply with requirements of NFPA 70.
- B Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C Products: Listed, classified, and labeled as suitable for the purpose intended.
- D Product Listing Organization Qualifications: Third party agencies shall be amongst those accredited by the NCBC (North Carolina Building Code Council) to label Electrical and Mechanical Equipment.

## 1.06 DELIVERY, STORAGE, AND PROTECTION

- A Store in a clean, dry space in original manufacturer's packaging until ready for installation.

## PART 2 PRODUCTS

### 2.01 WIRING DEVICE APPLICATIONS

- A Provide wiring devices suitable for intended use and with ratings adequate for load served.
- B For single receptacles installed on an individual branch circuit, provide receptacle with ampere rating not less than that of the branch circuit.
- C Provide weather resistant GFCI receptacles with specified weatherproof covers for receptacles installed outdoors or in damp or wet locations.
- D Provide GFCI protection for receptacles installed within 6 feet of sinks.
- E Provide GFCI protection for receptacles installed in kitchens.
- F Provide GFCI protection for receptacles serving electric drinking fountains.
- G Unless noted otherwise, do not use combination switch/receptacle devices.

### 2.02 WIRING DEVICE FINISHES

- A Provide wiring device finishes as described below unless otherwise indicated.
- B Wiring Devices, Unless Otherwise Indicated: Architect select color with stainless steel wall plate.
- C Wiring Devices Installed in Finished Spaces: Architect select color with stainless steel wall plate.
- D Wiring Devices Installed in Unfinished Spaces: Architect select color with galvanized steel wall plate.

### 2.03 WALL SWITCHES

- A Manufacturers:
  - 1. Hubbell Incorporated: [www.hubbell.com/#sle](http://www.hubbell.com/#sle).
  - 2. Leviton Manufacturing Company, Inc.
  - 3. Pass & Seymour, a brand of Legrand North America, Inc
  - 4. Approved Equal.
- B Wall Switches - General Requirements: AC only, quiet operating, general-use snap switches with silver alloy contacts, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 20; types as indicated on the drawings.
  - 1. Wiring Provisions: Terminal screws for side wiring and screw actuated binding clamp for back wiring with separate ground terminal screw.
- C Standard Wall Switches: Industrial heavy duty grade, 20 A, 120/277 V with standard toggle type switch actuator and maintained contacts; single pole single throw, three way, or four way as indicated on the drawings.

### 2.04 WALL DIMMERS

- A Manufacturers:
  - 1. Leviton Manufacturing Company, Inc.
  - 2. Lutron Electronics Company, Inc.
  - 3. Pass & Seymour, a brand of Legrand North America, Inc
  - 4. Or approved equal.
- B Wall Dimmers - General Requirements: Solid-state with continuous full-range even control following square law dimming curve, integral radio frequency interference filtering, power failure preset memory, air gap switch accessible without removing wall plate, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 1472; types and ratings suitable for load controlled as indicated on the drawings.
- C Provide accessory wall switches to match dimmer appearance when installed adjacent to each other.
- D Contractor shall ensure dimmer switch compatibility with luminaire controlled prior to ordering.

### 2.05 RECEPTACLES

- A Manufacturers:
  - 1. Hubbell Incorporated: [www.hubbell.com/#sle](http://www.hubbell.com/#sle).
  - 2. Leviton Manufacturing Company, Inc.
  - 3. Pass & Seymour, a brand of Legrand North America, Inc.
  - 4. Approved equal.

5. Source Limitations: Where wall controls are furnished as part of lighting control system, provide accessory matching receptacles and wallplates by the same manufacturer in locations indicated.
- B Receptacles - General Requirements: Self-grounding, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 498 and where applicable FS W-C-596; types as indicated on the drawings.
  1. Wiring Provisions: Terminal screws for side wiring or screw actuated binding clamp for back wiring with separate ground terminal screw.
  2. NEMA configurations specified are according to NEMA WD 6.
- C Convenience Receptacles:
  1. Standard Convenience Receptacles: Industrial Heavy Duty Grade, 20A, 125V, NEMA 5-20R; single or duplex as indicated on the drawings.
- D GFCI Receptacles:
  1. GFCI Receptacles - General Requirements: Self-testing, with feed-through protection and light to indicate ground fault tripped condition and loss of protection; listed as complying with UL 943, class A.
    - a. Provide test and reset buttons of same color as device.
  2. Standard GFCI Receptacles: Extra Heavy Duty Grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style.
  3. Weather Resistant GFCI Receptacles: Commercial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations.

## 2.06 WALL PLATES

- A Manufacturers:
  1. Hubbell Incorporated.
  2. Leviton Manufacturing Company, Inc.
  3. Pass & Seymour, a brand of Legrand North America, Inc.
  4. Source Limitations: Where wall controls are furnished as part of lighting control system, provide accessory matching receptacles and wallplates by the same manufacturer in locations indicated.
- B Wall Plates: Comply with UL 514D.
  1. Configuration: One piece cover as required for quantity and types of corresponding wiring devices.
  2. Size: Semi-Jumbo; Midi Size.
  3. Screws: Metal with slotted heads finished to match wall plate finish.
- C Stainless Steel Wall Plates: Brushed satin finish, Type 302 stainless steel.
- D Galvanized Steel Wall Plates: Rounded corners and edges, with corrosion resistant screws.
- E Weatherproof Covers for Wet and Damp Locations: Gasketed, thermoplastic, with self-closing hinged cover and corrosion-resistant screws; listed as suitable for use in wet locations with cover closed. Covers must be weatherproof while in use.

## PART 3 EXECUTION

### 3.01 EXAMINATION

- A Verify that field measurements are as indicated.
- B Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.
- C Verify that wall openings are neatly cut and will be completely covered by wall plates.
- D Verify that final surface finishes are complete, including painting.
- E Verify that floor boxes are adjusted properly.
- F Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.
- G Verify that conditions are satisfactory for installation prior to starting work.

### 3.02 PREPARATION

- A Provide extension rings to bring outlet boxes flush with finished surface.
- B Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

### 3.03 INSTALLATION

- A Perform work in a neat and workmanlike manner.

- B Coordinate locations of outlet boxes provided under Section 26 05 33.16 as required for installation of wiring devices provided under this section.
  - 1. Orient outlet boxes for vertical installation of wiring devices unless otherwise indicated.
  - 2. Where multiple receptacles, wall switches, or wall dimmers are installed at the same location and at the same mounting height, gang devices together under a common wall plate.
  - 3. Locate receptacles for electric drinking fountains concealed behind drinking fountain according to manufacturer's instructions.
- C Install wiring devices in accordance with manufacturer's instructions.
- D Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
- E Where required, connect wiring devices using pigtails not less than 6 inches long. Do not connect more than one conductor to wiring device terminals.
- F Connect wiring devices by wrapping conductor clockwise 3/4 turn around screw terminal and tightening to proper torque specified by the manufacturer. Where present, do not use push-in pressure terminals that do not rely on screw-actuated binding.
- G Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
- H Provide GFCI receptacles with integral GFCI protection at each location indicated. Do not use feed-through wiring to protect downstream devices.
- I Install wiring devices plumb and level with mounting yoke held rigidly in place.
- J Install wall switches with OFF position down.
- K Install wall dimmers to achieve full rating specified and indicated after derating for ganging as instructed by manufacturer.
- L Do not share neutral conductor on branch circuits utilizing wall dimmers.
- M Install vertically mounted receptacles with grounding pole on top and horizontally mounted receptacles with grounding pole on left.
- N Where receptacles are indicated to be mounted above counters they shall be mounted horizontally.
- O Install wall plates to fit completely flush to wall with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings.
- P Install blank wall plates on junction boxes and on outlet boxes with no wiring devices installed or designated for future use.

### 3.04 FIELD QUALITY CONTROL

- A Inspect each wiring device for damage and defects.
- B Operate each wall switch and wall dimmer with circuit energized to verify proper operation.
- C Test each receptacle to verify operation and proper polarity.
- D Test each GFCI receptacle for proper tripping operation according to manufacturer's instructions.
- E Correct wiring deficiencies and replace damaged or defective wiring devices.

### 3.05 ADJUSTING

- A Adjust devices and wall plates to be flush and level.
- B Adjust presets for wall dimmers according to manufacturer's instructions as directed by Architect.

### 3.06 CLEANING

- A Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

**END OF SECTION 26 27 26**

**SECTION 26 28 13**  
**FUSES**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A Fuses.
- B Spare fuse cabinet.

**1.02 REFERENCE STANDARDS**

- A NFPA 70 - National Electrical Code; National Fire Protection Association, Including All Applicable Amendments and Supplements; 2020.
- B UL 248-4 - Low-Voltage Fuses - Part 4: Class CC Fuses; Current Edition, Including All Revisions.
- C UL 248-8 - Low-Voltage Fuses - Part 8: Class J Fuses; Current Edition, Including All Revisions.
- D UL 248-10 - Low-Voltage Fuses - Part 10: Class L Fuses; Current Edition, Including All Revisions.
- E UL 248-12 - Low-Voltage Fuses - Part 12: Class R Fuses; Current Edition, Including All Revisions.
- F UL 248-15 - Low-Voltage Fuses - Part 15: Class T Fuses; Current Edition, Including All Revisions.

**1.03 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 Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

**1.04 SUBMITTALS**

- A Product Data: Provide manufacturer's standard data sheets including voltage and current ratings, interrupting ratings, time-current curves, and current limitation curves.
  - 1. Spare Fuse Cabinet: Include dimensions.
- B Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
  - 1. See Section 01 60 00 - Product Requirements, for additional provisions.
  - 2. Extra Fuses: One set(s) of three for each type and size installed.
  - 3. Fuse Pullers: One set(s) compatible with each type and size installed.
  - 4. Spare Fuse Cabinet Keys: Two.

**1.05 QUALITY ASSURANCE**

- A Comply with requirements of NFPA 70.
- B Product Listing Organization Qualifications: Third party agencies shall be amongst those accredited by the NCBC (North Carolina Building Code Council) to label Electrical and Mechanical Equipment.

**PART 2 PRODUCTS**

**2.01 MANUFACTURERS**

- A Bussmann, a division of Eaton Corporation.
- B Littelfuse, Inc.
- C Mersen.
- D Approved equal.

**2.02 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 Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.



- H Provide the following accessories where indicated or where required to complete installation:
1. Fuseholders: Compatible with indicated fuses.

**2.03 SPARE FUSE CABINET**

- A Description: Wall-mounted sheet metal cabinet with shelves and hinged door with cylinder lock, suitably sized to store spare fuses and fuse pullers specified.
- B Cabinet shall be located in the main electrical room unless otherwise indicated by owner.
- C Finish: Manufacturer's standard, factory applied grey finish unless otherwise indicated.

**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 mounting surfaces are ready to receive spare fuse cabinet.
- C 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.
- C Install spare fuse cabinet where indicated.
- D Identify spare fuse cabinet in accordance with Section 26 05 53.

**END OF SECTION 26 28 13**

**SECTION 26 28 16.16**  
**ENCLOSED SWITCHES AND CIRCUIT BREAKERS**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A Enclosed safety switches.
- B Enclosed circuit breakers.

**1.02 REFERENCE STANDARDS**

- A UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.
- B NFPA 70 - National Electrical Code; National Fire Protection Association, Including All Applicable Amendments and Supplements; 2020.

**1.03 ADMINISTRATIVE REQUIREMENTS**

- A Coordination:
  - 1. Coordinate the work with other trades. Avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and within 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. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
  - 4. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

**1.04 SUBMITTALS**

- A Product Data: Provide manufacturer's standard catalog pages and data sheets for enclosed switches and other installed components and accessories.
- B Shop Drawings: Indicate outline and support point dimensions, voltage and current ratings, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
  - 1. Include wiring diagrams showing all factory and field connections.
  - 2. Contractor shall confirm that all lug sizes and quantities submitted are compatible with the conductors specified on the contract documents. Changes required to lug sizes and quantities due to lack of coordination between the contractor and the supplier are to be made at the contractor's expense.
  - 3. It is the contractor's responsibility to ensure that the equipment submitted to comply with the requirements of this section are in compliance with the requirements and recommendations of the power system studies. Any changes recommended by the power system study shall be incorporated at no expense to the project.
- C Field Quality Control Test Reports.
- D Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
- E Project Record Documents: Record actual locations of enclosed switches or circuit breakers.
- F Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

**1.05 QUALITY ASSURANCE**

- A Comply with requirements of NFPA 70.
- B Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C Product Listing Organization Qualifications: Third party agencies shall be amongst those accredited by the NCBC (North Carolina Building Code Council) to label Electrical and Mechanical Equipment.

**1.06 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 enclosed switch internal components, enclosure, and finish.

### **1.07 FIELD CONDITIONS**

- A Maintain ambient temperature between 23 degrees F and 104 degrees F during and after installation of enclosed circuit breakers.

## **PART 2 PRODUCTS**

### **2.01 MANUFACTURERS**

- A ABB/GE: [www.geindustrial.com/#sle](http://www.geindustrial.com/#sle).
- B Eaton Corporation.
- C Schneider Electric; Square D Products.
- D Source Limitations: Furnish enclosed switches and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

### **2.02 ENCLOSED SAFETY SWITCHES**

- A Description: Quick-make, quick-break enclosed safety switches listed and labeled as complying with UL 98; heavy duty; ratings, configurations, and features as indicated on the drawings.
- B Provide products listed, classified, and labeled as suitable for the purpose intended.
- C All switches shall be heavy duty type.
- D Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
  - 1. Altitude: Less than 6,600 feet.
  - 2. Ambient Temperature: Between -22 degrees F and 104 degrees F.
- E Horsepower Rating: Suitable for connected load.
- F Voltage Rating: Suitable for circuit voltage.
- G Auxiliary Contacts: Suitable for 120v rated control circuit. Contractor is to provide auxiliary contacts in any disconnecting means that is downstream from a frequency drive. aux contacts shall be mechanically tied to switching mechanisms and shall provide both a N.O. and N.C. contacts. verify with DIV 23 prior to ordering equipment.
- H Short Circuit Current Rating:
  - 1. Provide enclosed safety switches, when protected by the fuses or supply side overcurrent protective devices to be installed, with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.
  - 2. When a power system study is included in the contract, confirm the short circuit current rating of all devices with the results of the study prior to submitting for approval.
- I Enclosed Safety Switches Used for Service Entrance: Listed and labeled as suitable for use as service equipment according to UL 869A.
- J Provide with switch blade contact position that is visible when the cover is open.
- K Fuse Clips for Fusible Switches: As required to accept fuses indicated.
  - 1. Where NEMA Class R fuses are installed, provide rejection feature to prevent installation of fuses other than Class R.
- L Conductor Terminations: Suitable for use with the conductors to be installed.
- M Provide insulated, groundable fully rated solid neutral assembly where a neutral connection is required, with a suitable lug for terminating each neutral conductor.
- N Provide solidly bonded equipment ground bus in each enclosed safety switch, with a suitable lug for terminating each equipment grounding conductor.
- O Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
  - 1. Environment Type per NEMA 250: As indicated on the drawings.
  - 2. Finish for Painted Steel Enclosures: Manufacturer's standard, factory applied grey unless otherwise indicated.
- P Provide safety interlock to prevent opening the cover with the switch in the ON position with capability of overriding interlock for testing purposes.
- Q Heavy Duty Switches:

1. Comply with NEMA KS 1.
2. Conductor Terminations:
  - a. Provide mechanical lugs for switch ratings less than 400 amperes.
  - b. Provide compression lugs for switch ratings 400 amperes and above.
  - c. Lug Material: Copper, suitable for terminating copper conductors only.
3. Provide externally operable handle with means for locking in the OFF position, capable of accepting three padlocks.

### 2.03 ENCLOSED CIRCUIT BREAKERS

- A Description: Units consisting of molded case circuit breakers individually mounted in enclosures.
- B Provide products listed, classified, and labeled as suitable for the purpose intended.
- C Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
  1. Altitude: Less than 6,600 feet.
  2. Ambient Temperature: Between 23 degrees F and 104 degrees F.
- D Short Circuit Current Rating:
  1. Provide enclosed circuit breakers with listed short circuit current rating not less than the available fault current at the installed location indicated on the drawings.
- E Enclosed Circuit Breakers Used for Service Entrance: Listed and labeled as suitable for use as service equipment according to UL 869A.
- F Auxiliary Contacts: Suitable for 120v rated control circuit. Contractor is to provide auxiliary contacts in any disconnecting means that is downstream from a frequency drive. aux contacts shall be mechanically tied to switching mechanisms and shall provide both a N.O. and N.C. contacts. verify with DIV 23 prior to ordering equipment.
- G Conductor Terminations: Suitable for use with the conductors to be installed.
- H Provide thermal magnetic circuit breakers for circuit breaker frame sizes less than 250 amperes.
- I Provide electronic trip circuit breakers for circuit breaker frame sizes 250 amperes and above.
- J Provide insulated, groundable fully rated solid neutral assembly where a neutral connection is required, with a suitable lug for terminating each neutral conductor.
- K Provide solidly bonded equipment ground bus in each enclosed circuit breaker, with a suitable lug for terminating each equipment grounding conductor.
- L Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
  1. Environment Type per NEMA 250: As indicated on the drawings.
  2. Finish for Painted Steel Enclosures: Manufacturer's standard, factory applied grey unless otherwise indicated.
  3. Provide surface-mounted enclosures unless otherwise indicated.
- M Provide externally operable handle with means for locking in the OFF position.
- N Ground Fault Protection: Where ground-fault protection is indicated, provide system listed and labeled as complying with UL 1053.
  1. Where electronic circuit breakers equipped with integral ground fault protection are used, provide separate neutral current sensor where applicable.
- O Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.
- P MOLDED CASE CIRCUIT BREAKERS
  1. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
  2. Interrupting Capacity:
    - a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated.
    - b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated. Series rating is not allowed.
  3. Conductor Terminations:

- a. Provide mechanical lugs for circuit breaker frame sizes less than 400 amperes.
- b. Provide compression lugs for circuit breaker frame sizes 400 amperes and above.
- c. Lug Material: Copper, suitable for terminating copper conductors only.
4. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
  - a. Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 100 amperes and larger.
5. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.
  - a. Provide the following individually field-adjustable trip response settings:
    - 1) Long time pickup, adjustable by setting dial.
    - 2) Long time delay.
    - 3) Short time pickup and delay.
    - 4) Instantaneous pickup.
    - 5) Ground fault pickup and delay where ground fault protection is indicated.
6. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.

### **PART 3 EXECUTION**

#### **3.01 EXAMINATION**

- A Verify that field measurements are as indicated.
- B Verify that the ratings of the enclosed switches are consistent with the indicated requirements.
- C Verify that mounting surfaces are ready to receive enclosed safety switches.
- 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 enclosed switches securely, in a neat and workmanlike manner.
- 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 05 29.
- E Install enclosed switches and breakers plumb.
- F Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed switches such that the highest position of the operating handle does not exceed 79 inches above the floor or working platform.
- G Provide grounding and bonding in accordance with Section 26 05 26.
- H Provide fuses complying with Section 26 28 13 for fusible switches as indicated or as required by equipment manufacturer's recommendations.
- I Set field-adjustable circuit breaker tripping function settings as directed.
- J Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.
- K Identify enclosed switches and breakers in accordance with Section 26 05 53.

#### **3.03 FIELD QUALITY CONTROL**

- A Perform inspections and tests listed in NETA ATS, Section 7.5.1.1 for breakers larger than 600A.
  1. Verify equipment nameplate is in accordance with contract documents.
  2. Inspect physical and mechanical condition.
  3. Inspect anchorage and alignment.
  4. Verify unit is clean.
  5. Operate breaker to ensure smooth operation.
  6. Perform breaker adjustments in accordance with the power system study.
  7. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
  8. Perform insulation-resistance test for one minute on each pole, phase-to-phase and phase-to-ground with circuit breaker closed.
  9. Perform contact/pole resistance test.
  10. Determine long-time and short time pickup and delay settings by primary current injection.

11. Determine ground fault pickup and time delay by primary current injection.

B Correct deficiencies and replace damaged or defective enclosed safety switches 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 switch enclosures and components according to manufacturer's instructions.

B Repair scratched or marred exterior surfaces to match original factory finish.

**END OF SECTION 26 28 16.16**

**SECTION 26 43 00**  
**SURGE PROTECTIVE DEVICES**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A Surge protective devices for service entrance locations.

**1.02 REFERENCE STANDARDS**

- A UL 1283 - Standard for Electromagnetic Interference Filters; Current Edition, Including All Revisions.
- B UL 1449 - Standard for Surge Protective Devices; Current Edition, Including All Revisions.
- C NFPA 70 - National Electrical Code; National Fire Protection Association, Including All Applicable Amendments and Supplements; 2020.

**1.03 ADMINISTRATIVE REQUIREMENTS**

- A Coordination: Coordinate size and location of overcurrent device compatible with the actual surge protective device and location to be installed. Notify Architect of any conflicts or deviations from Contract Documents to obtain direction prior to ordering equipment.

**1.04 SUBMITTALS**

- A Product Data: Include detailed component information, voltage, surge current ratings, repetitive surge current capacity, voltage protection rating (VPR) for all protection modes, maximum continuous operating voltage (MCOV), nominal discharge current (I-n), short circuit current rating (SCCR), connection means including any required external overcurrent protection, enclosure ratings, outline and support point dimensions, weight, service condition requirements, and installed features.
  - 1. SPDs with EMI/RFI filter: Include noise attenuation performance.
- B Shop Drawings: Include wiring diagrams showing all factory and field connections with wire and circuit breaker/fuse sizes.
- C Certificates: Manufacturer's documentation of listing for compliance with the following standards:
  - 1. UL 1449.
  - 2. UL 1283 (for Type 2 SPDs).
- D Field Quality Control Test Reports.
- E Manufacturer's Installation Instructions: Include application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- F Operation and Maintenance Data: Include information on status indicators and recommended maintenance procedures and intervals.
- G Warranty: Submit sample of manufacturer's warranty and documentation of final executed warranty completed in Owner's name and registered with manufacturer.
- H Project Record Documents: Record actual connections and locations of surge protective devices.

**1.05 QUALITY ASSURANCE**

- A Comply with requirements of NFPA 70.
- B Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C Product Listing Organization Qualifications: Third party agencies shall be amongst those accredited by the NCBC (North Carolina Building Code Council) to label Electrical and Mechanical Equipment.

**1.06 DELIVERY, STORAGE, AND PROTECTION**

- A Store in a clean, dry space in accordance with manufacturer's written instructions.

**1.07 FIELD CONDITIONS**

- A Maintain field conditions within manufacturer's required service conditions during and after installation.

**1.08 WARRANTY**

- A Manufacturer's Warranty: Provide minimum five year warranty covering repair or replacement of surge protective devices showing evidence of failure due to defective materials or workmanship.
- B Exclude surge protective devices from any clause limiting warranty responsibility for acts of nature, including lightning, stated elsewhere.

**PART 2 PRODUCTS**

**2.01 MANUFACTURERS**

- A Field-installed, Externally Mounted Surge Protective Devices:

1. ABB/GE: [www.geindustrial.com/#sle](http://www.geindustrial.com/#sle).
2. Current Technology; a brand of Thomas & Betts Power Solutions.
3. Schneider Electric; Square D Brand Surgelogic Products.
4. Liebert.
5. Approved equal.

B Source Limitations: Furnish surge protective devices produced by a single manufacturer and obtained from a single supplier.

## **2.02 SURGE PROTECTIVE DEVICES - GENERAL REQUIREMENTS**

- A Description: Factory-assembled surge protective devices (SPDs) for 60 Hz service; listed, classified, and labeled as suitable for the purpose intended; system voltage as indicated on the drawings.
- B Unless otherwise indicated, provide field-installed, externally-mounted or factory-installed, internally-mounted SPDs.
- C List and label as complying with UL 1449, Type 1 when connected on line side of service disconnect overcurrent device and Type 1 or 2 when connected on load side of service disconnect overcurrent device.
- D Protected Modes:
1. Wye Systems: L-N, L-G, N-G, L-L.
- E UL 1449 Voltage Protection Ratings (VPRs):
1. 208Y/120V System Voltage: Not more than 700 V for L-N, L-G, and N-G modes and 1,000 V for L-L mode.
- F UL 1449 Maximum Continuous Operating Voltage (MCOV): Not less than 115% of nominal system voltage.
- G Enclosure Environment Type per NEMA 250: As indicated on the drawings.
- H Mounting for Field-installed, Externally Mounted SPDs: Unless otherwise indicated, as specified for the following locations:
1. Provide surface-mounted SPD where mounted in non-public areas or adjacent to surface-mounted equipment.

## **2.03 SURGE PROTECTIVE DEVICES FOR SERVICE ENTRANCE LOCATIONS**

- A Unless otherwise indicated, provide field-installed, externally mounted SPDs.
- B Surge Current Rating:
1. Ampacity: 600 - 1000A 200 kA per mode 400 kA per phase.
  2. Ampacity: 225 - 400A 150 kA per mode 300 kA per phase.
  3. Ampacity: 125 - 225A 100 kA per mode 200 kA per phase.
- C Opening of supplementary protective devices, internal or external, shall not be permissible during UL 1449 3rd Edition Nominal Discharge testing.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A Verify that field measurements are as indicated.
- B Verify that the service voltage and configuration marked on the SPD are consistent with the service voltage and configuration at the location to be installed.
- C Verify that electrical equipment is ready to accept connection of the SPD and that installed overcurrent device is consistent with requirements of drawings and manufacturer's instructions.
- D Verify system grounding and bonding is in accordance with Section 26 05 26, including bonding of neutral and ground for service entrance and separately derived systems where applicable. Do not energize SPD until deficiencies have been corrected.
- E Verify that conditions are satisfactory for installation prior to starting work.

### **3.02 INSTALLATION**

- A Perform work in a neat and workmanlike manner.
- B Install products in accordance with manufacturer's instructions.
- C Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D Unless indicated otherwise, connect service entrance surge protective device on load side of service disconnect main overcurrent device.



- E Provide conductors with minimum ampacity not less than manufacturer's recommended minimum conductor size.
- F Install conductors between SPD and equipment terminations as short and straight as possible, not exceeding manufacturer's recommended maximum conductor length. Breaker locations may be reasonably rearranged in order to provide leads as short and straight as possible. Twist conductors together to reduce inductance.
- G Do not energize SPD until bonding of neutral and ground for service entrance and separately derived systems is complete in accordance with Section 26 05 26 where applicable. Replace SPDs damaged by improper or missing neutral-ground bond.
- H Disconnect SPD prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPD connected.

**3.03 FIELD QUALITY CONTROL**

- A Inspect and test in accordance with NETA ATS, except Section 4.
- B Perform inspections and tests listed in NETA ATS Section 7.19.1.
- C Procure services of a qualified manufacturer's representative to observe installation and assist in inspection, testing, and adjusting. Include manufacturer's reports with field quality control submittals.

**3.04 CLEANING**

- A Repair scratched or marred exterior surfaces to match original factory finish.

**END OF SECTION 26 43 00**

**SECTION 26 51 00**  
**INTERIOR AND EXTERIOR LIGHTING**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A Interior luminaires.
- B Emergency lighting units.
- C Exit signs.
- D LED Drivers.
- E Emergency power supply units.
- F Lamps.
- G Accessories.

**1.02 REFERENCE STANDARDS**

- A IES LM-79 - Approved Method: Optical and Electrical Measurements of Solid-State Lighting Products; 2019.
- B NFPA 70 - National Electrical Code; National Fire Protection Association, Including All Applicable Amendments and Supplements; 2020.
- C NFPA 101 - Life Safety Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D UL 924 - Emergency Lighting and Power Equipment; Current Edition, Including All Revisions.
- E UL 1598 - Luminaires; Current Edition, Including All Revisions.
- F UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products; Current Edition, Including All Revisions.

**1.03 ADMINISTRATIVE REQUIREMENTS**

- A Coordination:
  - 1. Coordinate the installation of luminaires with mounting surfaces installed under other sections or by others. Coordinate the work with placement of supports, anchors, etc. required for mounting. Coordinate compatibility of luminaires and associated trims with mounting surfaces at installed locations.
  - 2. Coordinate the placement of luminaires with structural members, ductwork, piping, equipment, diffusers, fire suppression system components, and other potential conflicts installed under other sections or by others.
  - 3. Coordinate the placement of exit signs with furniture, equipment, signage or other potential obstructions to visibility installed under other sections or by others.
  - 4. Notify Architect of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.

**1.04 SUBMITTALS**

- A Shop Drawings:
  - 1. Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.
- B Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, installed accessories, and ceiling compatibility; include model number nomenclature clearly marked with all proposed features.
  - 1. Drivers: Include wiring diagrams and list of compatible lamp configurations.
  - 2. Lamps: Include rated life, color temperature, color rendering index (CRI), and initial and mean lumen output.
- C Certificates for Dimming Drivers: Manufacturer's documentation of compatibility with dimming controls to be installed.
- D Field quality control reports.
- E Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

- F Warranties.
- G Operation and Maintenance Data: Instructions for each product including information on replacement parts.
- H Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
  - 1. Extra Lenses and Louvers: Two percent of total quantity installed for each type, but not less than one of each type.
  - 2. Extra Dri: Two percent of total quantity installed for each type, but not less than one of each type.

#### **1.05 QUALITY ASSURANCE**

- A Comply with requirements of NFPA 70.
- B Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C Product Listing Organization Qualifications: Third party agencies shall be amongst those accredited by the NCBC (North Carolina Building Code Council) to label Electrical and Mechanical Equipment.

#### **1.06 DELIVERY, STORAGE, AND PROTECTION**

- A Receive, handle, and store products according to manufacturer's written instructions.
- B Keep products in original manufacturer's packaging and protect from damage until ready for installation.

#### **1.07 FIELD CONDITIONS**

- A Maintain field conditions within manufacturer's required service conditions during and after installation.

### **PART 2 PRODUCTS**

#### **2.01 LUMINAIRE TYPES**

- A Furnish products as indicated in luminaire schedule included on the drawings.

#### **2.02 LUMINAIRES**

- A Provide products that comply with requirements of NFPA 70.
- B Provide products that are listed and labeled as complying with UL 1598, where applicable.
- C Provide products listed, classified, and labeled as suitable for the purpose intended.
- D Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.
- E Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, supports, trims, accessories, etc. as necessary for a complete operating system.
- F Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.
- G Recessed Luminaires:
  - 1. Ceiling Compatibility: Comply with NEMA LE 4.
  - 2. Luminaires Recessed in Insulated Ceilings: Listed and labeled as IC-rated, suitable for direct contact with insulation and combustible materials.
  - 3. Luminaires Recessed in Sloped Ceilings: Provide suitable sloped ceiling adapters.
  - 4. Luminaires Recessed in Fire Rated Ceiling: Provide fire rated tenting to match the fire resistant rating of the surrounding ceiling.
- H LED Luminaires:
  - 1. Components: UL 8750 recognized or listed as applicable.
  - 2. Tested in accordance with IES LM-79 and IES LM-80.
  - 3. Outdoor: Provide a minimum of 10 kV integral surge suppression.
  - 4. Indoor: Provide a minimum of 2.5 kV integral surge suppression.
- I Luminaires Mounted in Continuous Rows: Provide quantity of units required for length indicated, with all accessories required for joining and aligning.

#### **2.03 EMERGENCY LIGHTING UNITS**

- A Description: Emergency lighting units complying with NFPA 101 and all applicable state and local codes, and listed and labeled as complying with UL 924.
- B Operation: Upon interruption of normal power source or brownout condition exceeding 20 percent voltage drop from nominal, solid-state control automatically switches connected lamps to integral battery power for minimum of 90 minutes of rated emergency illumination, and automatically recharges battery upon restoration of normal power source.
- C Battery:

1. Sealed maintenance-free nickel cadmium unless otherwise indicated on the lighting fixture schedule.
  2. Size battery to supply all connected lamps, including emergency remote heads where indicated.
- D Diagnostics: Provide power status indicator light and accessible integral test switch to manually activate emergency operation. All fixtures shall be equipped with self diagnostics in addition to the manual operation.
- E Provide low-voltage disconnect to prevent battery damage from deep discharge.
- F Accessories:
1. Provide compatible accessory mounting brackets where indicated or required to complete installation.
  2. Provide compatible accessory wire guards where indicated.

#### 2.04 EXIT SIGNS

- A Description: Exit signs complying with NFPA 101 and applicable state and local codes, and listed and labeled as complying with UL 924.
1. Number of Faces: Single- or double-face as indicated or as required for installed location.
  2. Directional Arrows: As indicated or as required for installed location.
- B Self-Powered Exit Signs:
1. Diagnostics: Provide power status indicator light and accessible integral test switch to manually activate emergency operation. All fixtures shall be equipped with self diagnostics in addition to the manual operation.
- C Accessories:
1. Provide compatible accessory wire guards where indicated.

#### 2.05 LED DRIVERS

- A Drivers - General Requirements:
1. Provide Drivers containing no polychlorinated biphenyls (PCBs).
  2. Minimum Efficiency/Efficacy: Provide ballasts complying with all current applicable federal and state Driver efficiency/efficacy standards.
- B Dimmable LED Drivers:
1. Dimming Range: Continuous dimming from 100 percent to ten percent relative light output unless dimming capability to lower level is indicated in the fixture schedule, without flicker.
  2. Control Compatibility: Fully compatible with the dimming controls to be installed. Refer to drawings.
  3. Square wave inverters shall not be used with LED emergency lighting. Sinusoidal wave inverters must be used.

#### 2.06 EMERGENCY POWER SUPPLY UNITS

- A Manufacturers:
1. Iota Engineering, LLC.
  2. Emergilite
  3. Dualite
  4. Philips Emergency Lighting/Bodine.
  5. Approved equal.
  6. Manufacturer Limitations: Where possible, for each type of luminaire provide fluorescent emergency power supply units produced by a single manufacturer.
- B Description: Self-contained emergency power supply units suitable for use with indicated luminaires, complying with NFPA 101 and all applicable state and local codes, and listed and labeled as complying with UL 924.
- C Compatibility:
1. Drivers: Compatible with electronic, standard magnetic, energy saving, and dimming AC ballasts, including those with end of lamp life shutdown circuits.
- D Operation: Upon interruption of normal power source, solid-state control automatically switches connected lamp(s) to the emergency power supply for minimum of 90 minutes of rated emergency illumination, and automatically recharges battery upon restoration of normal power source.
- E Unit shall have a maximum of 5% total harmonic distortion with sine wave output. Square wave output is not acceptable.
- F Battery: Sealed maintenance-free high-temperature nickel cadmium unless otherwise indicated. Normal expected life of 10 years.

- G Diagnostics: Provide accessible and visible multi-chromatic combination test switch/indicator light to display charge, test, and diagnostic status and to manually activate emergency operation.
- H Operating Temperature: From 32 degrees F to 122 degrees F unless otherwise indicated or required for the installed location.

## 2.07 LAMPS

- A Lamps - General Requirements:
  - 1. Unless explicitly excluded, provide new, compatible, operable lamps in each luminaire.
  - 2. Verify compatibility of specified lamps with luminaires to be installed. Where lamps are not specified, provide lamps per luminaire manufacturer's recommendations.
  - 3. Minimum Efficiency: Provide lamps complying with all current applicable federal and state lamp efficiency standards.
  - 4. Color Temperature Consistency: Unless otherwise indicated, for each type of lamp furnish products which are consistent in perceived color temperature. Replace lamps that are determined by the Architect to be inconsistent in perceived color temperature.
    - a. Unless otherwise noted on the drawings color temperatures shall be as listed below. Notify engineer if there is an inconsistency in color temperatures listed in the fixture schedule prior to ordering.
      - 1) Interior Lighting: 4000 K
      - 2) Exterior Lighting: 4000 K

## PART 3 EXECUTION

### 3.01 EXAMINATION

- A Verify that field measurements are as indicated.
- B Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate conductors in accordance with NFPA 70.
- C Verify that suitable support frames are installed where required.
- D Verify that branch circuit wiring installation is completed, tested, and ready for connection to luminaires.
- E Verify that conditions are satisfactory for installation prior to starting work.

### 3.02 PREPARATION

- A Provide extension rings to bring outlet boxes flush with finished surface.
- B Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

### 3.03 INSTALLATION

- A Coordinate locations of outlet boxes provided under Section 26 05 33.16 as required for installation of luminaires provided under this section.
- B All luminaire surge suppression shall be evaluated and tested in accordance with ANSI C62.41.2 standard.
- C Install products in accordance with manufacturer's instructions.
- D Provide required support and attachment in accordance with Section 26 05 29.
- E Install luminaires securely, in a neat and workmanlike manner.
- F Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.
- G Suspended Ceiling Mounted Luminaires:
  - 1. Do not use ceiling tiles to bear weight of luminaires.
  - 2. Do not use ceiling support system to bear weight of luminaires unless ceiling support system is certified as suitable to do so.
  - 3. Secure surface-mounted and recessed luminaires to ceiling support channels or framing members or to building structure.
  - 4. Secure pendant-mounted luminaires to building structure.
  - 5. Secure lay-in luminaires to ceiling support channels using listed safety clips at four corners.
  - 6. In addition to ceiling support wires, provide two galvanized steel safety wire(s), minimum 12 gauge, connected from opposing corners of each recessed luminaire to building structure.
- H Recessed Luminaires:
  - 1. Install trims tight to mounting surface with no visible light leakage.
  - 2. Non-IC Rated Luminaires: Maintain required separation from insulation and combustibles materials according to listing.

3. Luminaires Recessed in Fire-Rated Ceilings: Install using accessories and firestopping materials to meet regulatory requirements for fire rating.
- I Suspended Luminaires:
  1. Install using the suspension method indicated, with support lengths and accessories as required for specified mounting height.
  2. Provide minimum of two supports for each luminaire, with no more than 4 feet between supports.
  3. Install canopies tight to mounting surface.
- J Wall-Mounted Luminaires: Unless otherwise indicated, specified mounting heights are to center of luminaire.
- K Install accessories furnished with each luminaire.
- L Bond products and metal accessories to branch circuit equipment grounding conductor.
- M Emergency Lighting Units:
  1. Unless otherwise indicated, connect unit to unswitched power from same circuit feeding normal lighting in same room or area. Bypass local switches, contactors, or other lighting controls.
  2. Install lock-on device on branch circuit breaker serving units, where served by a dedicated circuit.
- N Exit Signs:
  1. Unless otherwise indicated, connect unit to unswitched power from same circuit feeding normal lighting in same room or area. Bypass local switches, contactors, or other lighting controls.
  2. Install lock-on device on branch circuit breaker serving units, where served by a dedicated circuit.
- O Emergency Power Supply Units:
  1. Unless otherwise indicated, connect unit to unswitched power from same circuit feeding normal ballast(s) in luminaire. Bypass local switches, contactors, or other lighting controls.
  2. Install lock-on device on branch circuit breaker serving units.
- P Identify luminaires connected to emergency power system in accordance with Section 26 05 53.
- Q Install lamps in each luminaire.
- R Lamp Burn-In: Operate lamps at full output for prescribed period per manufacturer's recommendations prior to use with any dimming controls. Replace lamps that fail prematurely due to improper lamp burn-in.

### 3.04 WARRANTY

- A Exit signs: Provide a minimum five year warranty. The battery shall have an additional 2 year pro rated warranty. Warranty period begins from the date of project acceptance.
- B Emergency Luminaires: Provide a minimum of 5 year warranty for emergency luminaires. Batteries shall be warranted for 3 years with an additional 3 year pro-rated warranty. Warranty period begins from the date of project acceptance.
- C Emergency Power supplies and inverters shall have a minimum of 10 year prorated warranty.

### 3.05 FIELD QUALITY CONTROL

- A Inspect each product for damage and defects.
- B Operate each luminaire after installation and connection to verify proper operation.
- C Test self-powered exit signs, emergency lighting units, and fluorescent emergency power supply units to verify proper operation upon loss of normal power supply. Test shall be conducted for 90 minutes in accordance with NEC 700. Test shall be conducted a maximum of 10 days prior to final inspection and light level readings recorded at the beginning and end of the test shall be submitted to the engineer for review.
- D Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy ballasts as determined by Architect.

### 3.06 ADJUSTING

- A Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by Architect. Secure locking fittings in place.
- B Aim and position adjustable emergency lighting unit lamps to achieve optimum illumination of egress path as required or as directed by Architect or authority having jurisdiction.
- C Exit Signs with Field-Selectable Directional Arrows: Set as indicated or as required to properly designate egress path as directed by Architect or authority having jurisdiction.

**3.07 CLEANING**

- A Clean surfaces according to manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.

**3.08 CLOSEOUT ACTIVITIES**

- A Demonstration: Demonstrate proper operation of luminaires to Architect, and correct deficiencies or make adjustments as directed.
- B After the designer final inspection prior to SCO final inspection and final acceptance replace all lamps that have failed and clean all lenses.

**3.09 PROTECTION**

- A Protect installed luminaires from subsequent construction operations.

**END OF SECTION 26 51 00**

**SECTION 27 10 00**  
**STRUCTURED CABLING FOR VOICE AND DATA**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A Communications system design requirements.
- B Communications pathways.
- C Copper cable and terminations.
- D Fiber optic cable and interconnecting devices.
- E Communications equipment room fittings.
- F Communications outlets.
- G Communications grounding and bonding.
- H Communications identification.

**1.02 RELATED REQUIREMENTS**

- A Section 07 84 00 - Firestopping.
- B Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- C Section 26 05 33.13 - Conduit for Electrical Systems.
- D Section 26 05 33.16 - Boxes and Cabinets.
- E Section 26 05 53 - Identification for Electrical Systems: Identification products.
- F Section 26 27 26 - Wiring Devices.

**1.03 REFERENCE STANDARDS**

- A TIA-455-21 - FOTP-21 - Mating Durability of Fiber Optic Interconnecting Devices; 1988a (Reaffirmed 2012).
- B TIA-568 (SET) - Commercial Building Telecommunications Cabling Standard Set; 2020.
- C TIA-568.2 - Balanced Twisted-Pair Telecommunications Cabling and Components Standards; 2009c, with Addendum (2016).
- D TIA-568.3 - Optical Fiber Cabling and Components Standard; 2016d.
- E TIA-569 - Telecommunications Pathways and Spaces; 2019e.
- F TIA-598 - Optical Fiber Cable Color Coding; 2014d, with Addendum (2018).
- G TIA-606 - Administration Standard for Telecommunications Infrastructure; 2021d.
- H TIA-607 - Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises; 2019d.
- I UL 444 - Communications Cables; Current Edition, Including All Revisions.
- J UL 514C - Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers; Current Edition, Including All Revisions.
- K UL 1651 - Fiber Optic Cable; Current Edition, Including All Revisions.
- L UL 1863 - Communications-Circuit Accessories; Current Edition, Including All Revisions.
- M NFPA 70 - National Electrical Code; National Fire Protection Association, Including All Applicable Amendments and Supplements; 2020.

**1.04 ADMINISTRATIVE REQUIREMENTS**

- A Preinstallation Meeting: Convene one week prior to commencing work of this section to review service requirements and details with Communications Service Provider representative.
- B Provide all labor, equipment, supplies, materials, and incidentals and all operations necessary for the "TURNKEY," fully operational, tested, and completed installation of a Complete Wiring Infrastructure to support owner supplied equipment for voice and data systems, in complete accordance with the Contract Documents.
- C Coordination:
  - 1. Coordinate the work with other trades to avoid placement of other utilities or obstructions within the spaces dedicated for communications equipment.
  - 2. Coordinate arrangement of communications equipment with the dimensions and clearance requirements of the actual equipment to be installed.
  - 3. Coordinate with the Electrical Contractor for the Grounding of all cable trays and relay racks / cabinets. Provide telecommunications ground bars at each network closet as identified on plans.



4. The Structured Wiring Contractor shall coordinate with the electrical contractor such that if additional conduit sleeves are required for installation of the cabling infrastructure then the electrical contractor shall provide, install and seal as required.
5. Coordination of the Raceway installation and racks & equipment placement with the Owners IT Department and Electrical Contractor.
6. The Structured Wiring Contractor shall coordinate required wiring for Phone lines Circuits for the Fire Alarm System. He shall provide and install the voice lines from that vendor's outlet / panel to the Owners phone equipment. Terminate as indicated by owner's IT department.
7. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

D Arrange for Communications Service Provider to provide service.

#### **1.05 SUBMITTALS**

- A Product Data: Provide manufacturer's standard catalog pages and data sheets for each product.
- B Shop Drawings: Show compliance with requirements on isometric schematic diagram of network layout, showing cable routings, telecommunication closets, rack and enclosure layouts and locations, service entrance, and grounding, prepared and approved by BICSI Registered Communications Distribution Designer (RCDD).
- C Evidence of qualifications for installer.
- D Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and operation of product.
- E Test Plan: Complete and detailed plan, with list of test equipment, procedures for inspection and testing, and intended test date; submit at least 60 days prior to intended test date.
- F Field Test Reports.
- G Project Record Documents: Prepared and approved by BICSI Registered Communications Distribution Designer (RCDD).
  1. Record actual locations of outlet boxes and distribution frames.
  2. Show as-installed color coding, pair assignment, polarization, and cross-connect layout.
  3. Identify distribution frames and equipment rooms by room number on drawings.
- H Operation and Maintenance Data: List of all components with part numbers, sources of supply, and operation and maintenance instructions; include copy of project record documents.

#### **1.06 QUALITY ASSURANCE**

- A Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- B Manufacturer Qualifications: At least 3 years experience manufacturing products of the type specified.
- C Installer Qualifications: A company having at least 7 years experience in the installation and testing of the type of system specified, and:
  1. Employing a BICSI Registered Communications Distribution Designer (RCDD).
  2. Supervisors and installers factory certified by manufacturers of products to be installed.
  3. Employing BICSI Registered Cabling Installation Technicians (RCIT) for supervision of all work.
- D Products: Listed, classified, and labeled as suitable for the purpose intended.
- E FCC Approval - The system shall be approved for direct interconnection to the telephone utility under Part 68 of FCC rules and regulations. Systems which are not FCC approved or utilized an intermediary device for connection, shall not be considered. Provide the FCC registration number of the system being proposed as a part of the submittal process.
- F Product Listing Organization Qualifications: Third party agencies shall be amongst those accredited by the NCBC (North Carolina Building Code Council) to label Electrical and Mechanical Equipment.

#### **1.07 DELIVERY, STORAGE, AND HANDLING**

- A Store products in manufacturer's unopened packaging until ready for installation.
- B Keep stored products clean and dry.

#### **1.08 WARRANTY**

- A Correct defective Work within a 1 year period after Date of Project Acceptance.

## **PART 2 PRODUCTS**

### **2.01 MANUFACTURERS**

- A Copper Cabling:
  - 1. General Cable.
  - 2. Panduit.
  - 3. Commscope.
  - 4. Superior Essex
  - 5. Or approved Equal
- B Fiber Cabling
  - 1. General Cable.
  - 2. Commscope.
  - 3. Corning.
  - 4. Or approved equal.
- C Connectivity:
  - 1. Panduit.
  - 2. Commscope.
  - 3. Leviton.
  - 4. Hubbell.
  - 5. Or approved equal.
- D Wall Cabinets:
  - 1. Middle Atlantic.
  - 2. Hoffman.
  - 3. Chatsworth.
  - 4. Hubbell.

### **2.02 SYSTEM DESIGN**

- A As part of this Project the Structured Wiring Contractor shall provide and install ALL cabinets, relay racks /surge suppressor strips, horizontal /vertical wire management, Patch panels (Fiber / Copper) and Patch cords (Fiber / Copper), faceplates, connectors fiber/copper, SMB boxes for WAPS and Cameras, etc. for a fully complete infrastructure. Coordinate closely with the owners IT staff for placement of equipment in racks to accommodate owner provided network switches.
- B Permits and Inspections: Obtain and pay for all permits and inspections required by all legal authorities and agencies having jurisdiction for the work. These permits or inspections shall be a part of the work of the Contractor performing the work.
- C Provide a complete permanent system of cabling and pathways for voice and data communications, including cables, conduits and wireways, pull wires, support structures, enclosures and cabinets, and outlets.
  - 1. Comply with TIA-568 (SET) (cabling) and TIA-569 (pathways) (commercial standards).
  - 2. Comply with Communications Service Provider requirements.
  - 3. Provide fixed cables and pathways that comply with NFPA 70 and TIA-607 and are UL listed or third party independent testing laboratory certified.
  - 4. Provide connection devices that are rated for operation under conditions of 32 to 140 degrees F at relative humidity of 0 to 95 percent, noncondensing.
  - 5. In this project, the term plenum is defined as return air spaces above ceilings, inside ducts, under raised floors, and other air-handling spaces.
- D Existing Main Distribution Frame (MDF): Is located in the existing Building, refer to Plans.
- E Intermediate Distribution Frames (IDF): Support structures for terminating horizontal cables that extend to telecommunications outlets.
  - 1. Locate intermediate distribution frames as indicated on the drawings.
- F Backbone Cabling: Cabling, pathways, and terminal hardware connecting intermediate distribution frames (IDF's) with main distribution frame (MDF), wired in star topology with main distribution frame at center hub of star.
- G Cabling to Outlets: Specified horizontal cabling, wired in star topology to distribution frame located at center hub of star; also referred to as "links".

H Refer to Drawings for Data / Voice /TV / Access Point / SIP Phone and I/P Camera locations.

### 2.03 PATHWAYS

- A Conduit: As specified in Section 26 05 33.13; provide pull cords in all conduit.
- B All telecommunications stub-ups and sleeves shall have insulated bushings to protect cabling. Bushings must be plenum rated.

### 2.04 COPPER CABLE AND TERMINATIONS

- A Provide cables with lead content less than 300 parts per million.
- B Copper Horizontal Cable: (Plenum Rated)
  - 1. Description: 100 ohm, balanced twisted pair cable complying with TIA-568.2 and listed and labeled as complying with UL 444.
  - 2. Cable Type - Voice and Data: TIA-568.2 Category 6 UTP (unshielded twisted pair); 23 AWG.
  - 3. Cable Capacity: 4-pair.
  - 4. Cable Applications:
    - a. Plenum Applications: Use listed NFPA 70 Type CMP plenum cable.
  - 5. Cable Jacket Color -Data & Sip Phone Cable: Blue.
  - 6. Cable Jacket Color - Voice Cable: White.
  - 7. Cable Jacket Color - Camera: Green.
  - 8. Cable Jacket Color - Wireless Access Points: Yellow
- C Copper Cable Terminations: Insulation displacement connection (IDC) type using appropriate tool; use screw connections only where specifically indicated.
- D Jacks and Connectors: Modular RJ-45, non-keyed, terminated with 110-style insulation displacement connectors (IDC); high impact thermoplastic housing; suitable for and complying with same standard as specified horizontal cable; UL 1863 listed.
  - 1. Performance: 500 mating cycles.
  - 2. Voice and Data Jacks: 8-position modular jack, color-coded for both T568A and T568B wiring configurations.
- E Copper Patch Cords:
  - 1. Description: Factory-fabricated 4-pair cable assemblies with 8-position modular connectors terminated at each end.
  - 2. Patch Cords for Patch Panels:
    - a. Quantity: 200, Length 3 ft.
    - b. Quantity: 20, Length 10 ft.
    - c. Quantity: 20, Length 3ft (Green for Camera's)
    - d. Quantity: 20, Length 3ft (Yellow for Wireless Access Points)

### 2.05 FIBER OPTIC CABLE AND INTERCONNECTING DEVICES

- A Provide cables with lead content less than 300 parts per million.
- B Fiber Optic Backbone Cable: (Plenum Rated)
  - 1. Description: Tight buffered, non-conductive fiber optic cable complying with TIA-568.3, TIA-598, ICEA S-83-596 and listed as complying with UL 444 and UL 1651.
  - 2. Cable Type: Multimode, laser-optimized 50/125 um (OM3) complying with TIA-492AAAC.
  - 3. Cable Capacity: 12 -fiber.
  - 4. Cable Applications:
    - a. Provide Fiber backbone cabling between the MDF and each IDF closet in a star topology.
    - b. Plenum Applications: Use listed NFPA 70 Type OFNP plenum cable.
  - 5. Cable Jacket Color:
    - a. Laser-Optimized Multimode Fiber (OM3/OM4): Aqua.
- C In field splicing of fiber optic cables shall not be permitted.
- D Fiber Optic Interconnecting Devices:
  - 1. Connector Type: SC.
  - 2. Connector Performance: 500 mating cycles, when tested in accordance with TIA-455-21.
  - 3. Connector tip material shall be ceramic;
  - 4. Connectors shall accept a maximum fiber jacket diameter of 3.0 mm;

5. Connectors shall be spring loaded, bayonet style for a positive contact;
6. Connectors shall be keyed to prevent rotation after insertion;
7. Connectors shall utilize cured adhesive methods for assembly;
8. Maximum Attenuation/Insertion Loss: 0.3 dB.
9. All fibers shall be terminated.

## 2.06 COMMUNICATIONS EQUIPMENT ROOM FITTINGS

### A Copper Cross-Connection Equipment:

1. Patch Panels for Copper Cabling: Sized to fit EIA/ECA-310 standard 19 inch wide equipment racks; 0.09 inch thick aluminum; cabling terminated on Type 110 insulation displacement connectors; printed circuit board interface.
  - a. Jacks: Non-keyed RJ-45, suitable for and complying with same standard as cable to be terminated; maximum 48 ports per standard width panel.
  - b. Capacity: Provide ports sufficient for cables to be terminated plus 25 percent spare.
  - c. Labels: Factory installed laminated plastic nameplates above each port, numbered consecutively; comply with TIA-606.
  - d. Provide incoming cable strain relief and routing guides on back of panel.
  - e. Provide cable management panels between each patch panel for twisted pair cable. Cable management panels shall be Panduit "WMP" series, or equal.

### B Fiber Optic Cross-Connection Equipment:

1. Patch Panels for Fiber Optic Cabling: Sized to fit EIA/ECA-310 standard 19 inch wide equipment racks; 0.09 inch thick aluminum.
  - a. Adapters: As specified above under FIBER OPTIC CABLE AND INTERCONNECTING DEVICES; maximum of 24 duplex adapters per standard panel width.
  - b. Labels: Factory installed laminated plastic nameplates above each port, numbered consecutively; comply with TIA-606.
  - c. Provide incoming cable strain relief and routing guides on back of panel.
  - d. Provide rear cable management tray at least 8 inches deep with removable cover.
  - e. Provide dust covers for unused adapters.

### C Equipment Frames, Racks and Cabinets:

1. Component Racks: EIA/ECA-310 standard 19 inch wide.
2. Wall Mounted Cabinets: Front plexiglas door, louvered side panels, top and bottom cable access, and ground lug. Provide front and rear piano hinge to access front and back of rack. Rack shall be HUBBELL MCC48WMC19D or approved equal.
  - a. Provide 1 cabinet in Room Number 608
3. Cabinets: Steel construction with corrosion resistant finish.

## 2.07 COMMUNICATIONS OUTLETS

### A Outlet Boxes: Comply with Section 26 05 33.16.

1. Provide depth as required to accommodate cable manufacturer's recommended minimum conductor bend radius.
2. Provide and install (SMB) boxes at the ends of cameras and Wireless Access points. Patch Cable shall be connected to SMB and other end will plug into device (Camera or Wireless Access Point).

### B Wall Plates:

1. Comply with system design standards and UL 514C.
2. Accepts modular jacks/inserts.
3. Capacity:
  - a. Data or Combination Voice/Data Outlets: 6 individual ports.
4. Wall Plate Material/Finish - Flush-Mounted Outlets: Match wiring device and wall plate finish stainless with ID window to match devices specified in Section 26 27 26.
  - a. Single gang, flush mountable.
  - b. Shall accept data, telephone, fiber optic, MATV, video, audio and blank insert modules;
  - c. Inserts shall snap in and out from the front of the Data Station Outlet;
  - d. Face plates shall be supplied with pressure-sensitive icon labels;

- e. At locations where Owner provided and installed VOIP wall phones are located the Structured Wiring Contractor shall coordinate with the owner for the compatible wall plate to support the owner provided VOIP phone.
- 5. Inserts (Insert colors shall match colors listed for cable type above. Coordinate final colors with owner)
  - a. Provide Data Port inserts with the following features: RJ-45 type rated for Category 6;
    - 1) RJ-45 insert shall be configured to EIA-568 wiring standards;
    - 2) Attenuation through the RJ-45 port at 10/16 MHz shall be less than .015/.025 dB;
    - 3) Provide 110 style IDC terminations for all eight conductors of a UTP cable;
    - 4) Data port inserts shall be by Panduit, Commscope, Hubbell, or Leviton.
  - b. Provide Telephone Inserts with the following features RJ-45 type rated for Category 6;
    - 1) RJ-45 insert shall be configured to USOC wiring standards;
    - 2) Provide 110 style IDC terminations for all six conductors of a UTP phone cable.
    - 3) Telephone inserts shall be by Panduit, Commscope, Hubbell, or Leviton
  - c. Provide Fiber Optic Inserts with the following features:
    - 1) SC-SC type, feed-through connector;
    - 2) Connector type shall be multi-mode;
    - 3) Insert shall provide two SC connectors;
    - 4) Fiber Optic Inserts shall be by

## 2.08 GROUNDING AND BONDING COMPONENTS

- A Comply with TIA-607.
- B Comply with Section 26 05 26.

## 2.09 IDENTIFICATION PRODUCTS

- A Comply with TIA-606.

## PART 3 EXECUTION

### 3.01 INSTALLATION - GENERAL

- A Comply with latest editions and addenda of TIA-568 (SET) (cabling), TIA-569 (pathways), TIA-607 (grounding and bonding), NECA/BICSI 568, NFPA 70, and SYSTEM DESIGN as specified in PART 2.
- B Comply with Communication Service Provider requirements.
- C Grounding and Bonding: Perform in accordance with TIA-607 and NFPA 70.
- D Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.

### 3.02 PATHWAYS

- A The Division 27 Wiring Contractor shall be responsible for reviewing and coordinating conduit installation for the Voice Data systems with the Division 26 Prime Contractor.

### 3.03 INSTALLATION OF EQUIPMENT AND CABLING

- A Cabling:
  - 1. Do not bend cable at radius less than manufacturer's recommended bend radius; for unshielded twisted pair use bend radius of not less than 4 times cable diameter.
  - 2. Do not over-cinch or crush cables.
  - 3. Do not exceed manufacturer's recommended cable pull tension.
  - 4. When installing in conduit, use only lubricants approved by cable manufacturer and do not chafe or damage outer jacket.
  - 5. Fiber cabling shall be routed using 1-1/4" minimum plenum rated innerduct supported with J-hooks at 36" on center.
- B Service Loops (Slack or Excess Length): Provide the following minimum extra length of cable, looped neatly:
  - 1. At Distribution Frames: 36 inches.
  - 2. At Outlets - Copper: 24 inches.
  - 3. At Outlets - Optical Fiber: 24 inches.
- C Copper Cabling:
  - 1. Category 6: Maintain cable geometry; do not untwist more than 1/2 inch from point of termination.
  - 2. For 4-pair cables in conduit, do not exceed 25 pounds pull tension.

3. Use T568B wiring configuration.
- D Fiber Optic Cabling:
  1. Prepare for pulling by cutting outer jacket for 10 inches from end, leaving strength members exposed. Twist strength members together and attach to pulling eye.
  2. Support vertical cable at intervals as recommended by manufacturer.
- E Wall-Mounted Enclosures:
  1. Install to plywood backboards only, unless otherwise indicated.
  2. Mount so height of topmost panel does not exceed 78 inches above floor.
  3. Enclosures shall be grounded.
  4. Coordinate placement of power outlets for electronics in enclosures prior to rough-in.
- F Identification:
  1. Use wire and cable markers to identify cables at each end.
  2. Use manufacturer-furnished label inserts, identification labels, or engraved wallplate to identify each jack at communications outlets with unique identifier.
  3. Use identification nameplate to identify cross-connection equipment, equipment racks, and cabinets.

### 3.04 FIELD QUALITY CONTROL

- A Comply with inspection and testing requirements of specified installation standards.
- B Visual Inspection:
  1. Inspect cable jackets for certification markings.
  2. Inspect cable terminations for color coded labels of proper type.
  3. Inspect outlet plates and patch panels for complete labels.
  4. Inspect patch cords for complete labels.
- C Testing - Copper Cabling and Associated Equipment:
  1. Test backbone cables for DC loop resistance, shorts, opens, intermittent faults, and polarity between connectors and between conductors and shield, if cable has overall shield.
  2. Test operation of shorting bars in connection blocks.
  3. Test each twisted pair cable segment (example: from the data station port through the patch bay and patch cable to the hub port connector). Publish a log of each test to verify that the cable segment passes the EIA/TIA-568 TEB-36 requirements for Category 6 compliance. Bind the test log in a booklet and turn the booklet over to the Owner. The test shall include:
    - a. Connector/cable continuity - line mapping;
    - b. Cable segment length;
    - c. Dual near end cross talk (NEXT);
    - d. Attenuation at 100 MHz;
    - e. Attenuation per foot;
    - f. Pass/fail results of each portion of the test above.
- D Testing - Fiber Optic Cabling:
  1. Backbone: Perform optical fiber end-to-end attenuation test using an optical time domain reflectometer (OTDR) and manufacturer's recommended test procedures; perform verification acceptance tests and factory reel tests.
  2. Multimode Backbone: Perform tests in accordance with TIA-526-14.
- E Final Testing: After all work is complete, including installation of telecommunications outlets, and telephone dial tone service is active, test each voice jack for dial tone.

**END OF SECTION 27 10 00**

**SECTION 27 51 13  
INTERCOM SYSTEM**

**INTERCOM SYSTEM**

**GENERAL REQUIREMENTS**

**THE CONDITIONS OF THE GENERAL CONTRACT (GENERAL, SUPPLEMENTARY, AND OTHER CONDITIONS) AND THE GENERAL REQUIREMENTS ARE HEREBY MADE A PART OF THIS SECTION.**

**ALL BIDS SHALL BE BASED ON THE EQUIPMENT AS SPECIFIED HEREIN. THE CATALOG NUMBERS AND MODEL DESIGNATIONS ARE THAT OF THE BOGEN NYQUIST E7000 SERIES EDUCATIONAL SYSTEM (OR EQUAL). THE SPECIFYING AUTHORITY "OWNER" MUST PRE-APPROVE ANY ALTERNATIVE SYSTEM. REFER TO ARCHITECT'S LIST OF OWNER PREFERRED MAUNFACTURER;S FOR BOGEN NYQUIST.**

**PROJECT SCOPE:**

**EXPAND THE EXISTING BOGEN E7000 NYQUIST SYSTEM TO THE RENOVATED AREA AND NEW GYMNASIUM BUILDING. THIS SHALL INCLUDE ALL REQUIRED SPEAKERS, BACKBOXES, WIRING, SIP PHONES, PROGRAMMING, ETC. FOR A 100% COMPLETE AND OPERATIONAL SYSTEM.**

**THE CONTRACTOR FOR THIS WORK SHALL HAVE READ ALL THE BIDDING REQUIREMENTS, THE GENERAL REQUIREMENTS OF DIVISION 1, AND THE CONTRACT PROPOSAL FORMS, AND SHALL BE HELD TO THE EXECUTION OF THIS WORK. THE CONTRACTOR SHALL BE BOUND BY ALL THE CONDITIONS AND REQUIREMENTS THEREIN.**

**THE CONTRACTOR SHALL BE RESPONSIBLE FOR PROVIDING A COMPLETE FUNCTIONAL SYSTEM, INCLUDING ALL NECESSARY COMPONENTS WHETHER INCLUDED IN THIS SPECIFICATION OR NOT.**

**IN PREPARING THE BID, THE CONTRACTOR SHOULD CONSIDER THAT NO CLAIM WILL BE MADE AGAINST THE OWNER FOR ANY COSTS INCURRED BY THE CONTRACTOR FOR ANY EQUIPMENT DEMONSTRATIONS REQUESTED BY THE OWNER.**

**ALL CONDUIT, OUTLET BOXES, POWER SUPPLIES, AND RECEPTACLES SHALL BE PROVIDED AND INSTALLED BY THE ELECTRICAL CONTRACTOR AS PART OF THE BASE BID.**

**10.01 SCOPE OF WORK**

- A The contractor shall furnish and install all equipment, accessories, and materials in accordance with these specifications and drawings to provide a complete and operating VoIP school communications system including but not limited to:**

**ANALOG STATION BRIDGE (ASB) AS REQUIRED**

**11.01 24 STATION INTERFACE SUPPORTING ANALOG SPEAKERS**

**11.02 CATEGORY WIRING**

**11.03 25/70-VOLT SPEAKER(S), CEILING-MOUNTED, WALL-MOUNTED, AND PAGING HORNS**

**11.04 CAN BUS 2.0 INTERFACE DESIGNED FOR FUTURE SUPPORT OF A DIGITAL CALL SWITCH THAT CAN INITIATE NORMAL, URGENT, OR EMERGENCY PRIORITY CALLS, ALL WITH OPTIONS FOR PRIVACY MODE**

**MATRIX MIXER PRE-AMPLIFIER (MMPA) AS REQUIRED**

**INPUT/OUTPUT (I/O) CONTROLLER AS REQUIRED**

**13.01 POWER OVER ETHERNET (POE) CLASS-1 (IEEE 802.3AF COMPLIANT)**

**VOIP STAFF STATION, POE, 132 X 64-PIXEL GRAPHICAL LCD WITH BACKLIGHT AS REQUIRED**

**OWNER TELEPHONE SYSTEM CONNECTIVITY**

**15.01 SYSTEM SHALL BE CAPABLE OF CONNECTING TO THE PUBLIC SWITCHED TELEPHONE NETWORK (PSTN), ANALOG PUBLIC BRANCH EXCHANGE (PBX), OR DIGITAL PBX/IP-PBX BY CONNECTING TO AN UNLIMITED NUMBER OF SIP TRUNKS, ANALOG FXO/FXS LINES, OR CO TRUNKS.**

**15.02 TELEPHONE SERVICE WITH PUBLIC UTILITIES WILL BE ARRANGED BY THE OWNER IN CONJUNCTION WITH THE EQUIPMENT SUPPLIER. EQUIPMENT SUPPLIER SHALL GENERATE A ONE-PAGE DOCUMENT THAT WILL PROVIDE THE OWNER WITH THE NUMBER OF OUTSIDE LINES.**

**SUBMITTALS**

**SPECIFICATION SHEETS SHALL BE SUBMITTED ON ALL ITEMS INCLUDING CABLE TYPES  
SUBMIT OUTLINE DRAWING OF SYSTEM CONTROL CABINET SHOWING RELATIVE POSITION OF  
ALL MAJOR COMPONENTS**

**SHOP DRAWINGS, DETAILING INTEGRATED ELECTRONIC COMMUNICATIONS NETWORK  
SYSTEM INCLUDING, BUT NOT LIMITED TO, THE FOLLOWING:**

**19.01 STATION WIRING ARRANGEMENT**

**SUBMIT WIRING DIAGRAMS SHOWING TYPICAL CONNECTIONS FOR ALL EQUIPMENT  
SUBMIT A NUMBERED CERTIFICATE OF COMPLETION FOR INSTALLATION, PROGRAMMING,  
AND SERVICE TRAINING, WHICH IDENTIFIES THE INSTALLING TECHNICIAN(S) AS HAVING  
SUCCESSFULLY COMPLETED THE TECHNICAL TRAINING COURSE(S) PROVIDED BY THE SYSTEM  
MANUFACTURER.**

**QUALITY ASSURANCE**

**ALL ITEMS OF EQUIPMENT SHALL BE DESIGNED BY THE MANUFACTURER TO FUNCTION AS A  
COMPLETE SYSTEM AND SHALL BE ACCOMPANIED BY THE MANUFACTURER'S COMPLETE  
SERVICE NOTES AND DRAWINGS DETAILING ALL INTERCONNECTIONS.**

**THE CONTRACTOR SHALL BE AN ESTABLISHED COMMUNICATIONS AND ELECTRONICS  
CONTRACTOR THAT MAINTAINS A LOCALLY RUN AND OPERATED BUSINESS AND HAS DONE SO  
FOR AT LEAST 10 YEARS. THE CONTRACTOR SHALL BE A DULY AUTHORIZED DISTRIBUTOR OF  
THE EQUIPMENT SUPPLIED WITH FULL MANUFACTURER'S WARRANTY PRIVILEGES.**

**THE CONTRACTOR SHALL SHOW SATISFACTORY EVIDENCE, UPON REQUEST, THAT HE OR SHE  
MAINTAINS A FULLY EQUIPPED SERVICE ORGANIZATION CAPABLE OF FURNISHING ADEQUATE  
INSPECTION AND SERVICE TO THE SYSTEM. THE CONTRACTOR SHALL MAINTAIN AT HIS OR  
HER FACILITY THE NECESSARY SPARE PARTS IN THE PROPER PROPORTION AS RECOMMENDED  
BY THE MANUFACTURER TO MAINTAIN AND SERVICE THE EQUIPMENT BEING SUPPLIED.**

**SINGLE SOURCE RESPONSIBILITY**

**EXCEPT WHERE SPECIFICALLY NOTED OTHERWISE, ALL EQUIPMENT SUPPLIED SHALL BE THE  
STANDARD PRODUCT OF A SINGLE MANUFACTURER OF KNOWN REPUTATION AND A MINIMUM  
OF 35 YEARS OF EXPERIENCE IN THE INDUSTRY. THE SUPPLYING CONTRACTOR SHALL HAVE  
ATTENDED THE MANUFACTURER'S INSTALLATION AND SERVICE TRAINING CLASSES. A  
CERTIFICATE OF THIS TRAINING SHALL BE PROVIDED WITH THE CONTRACTOR'S SUBMITTAL.**

**SAFETY / COMPLIANCE TESTING**



**IN-SERVICE TRAINING  
WIRING**

**SYSTEM WIRING AND EQUIPMENT INSTALLATION SHALL BE IN ACCORDANCE WITH GENERALLY-ACCEPTED ENGINEERING BEST PRACTICES AS ESTABLISHED BY THE EIA AND THE NEC. WIRING SHALL MEET ALL STATE AND LOCAL ELECTRICAL CODES. ALL WIRING SHALL BE TESTED TO BE FREE FROM GROUNDS AND SHORTS.**

**ALL SYSTEM WIRING SHALL BE LABELED AT BOTH ENDS OF THE CABLE. ALL LABELING SHALL BE BASED ON THE ROOM NUMBERS AS INDICATED IN THE ARCHITECTURAL GRAPHICS PACKAGE.**

**WIRING SHALL BE DONE PER MANUFACTURER'S RECOMMENDATION (CAT 6 OR WEST PENN #357) DEPENDING ON SPEAKER TYPE.**

**PROTECTION**

**THE CONTRACTOR SHALL PROVIDE ALL NECESSARY TRANSIENT PROTECTION ON THE AC POWER FEED AND ON ALL STATION LINES LEAVING OR ENTERING THE BUILDING.**

**THE CONTRACTOR SHALL NOTE ON THEIR SYSTEM DRAWINGS, THE TYPE AND LOCATION OF THESE PROTECTION DEVICES AND ALL WIRING INFORMATION. SUCH DEVICES ARE NOT TO BE INSTALLED ABOVE THE CEILING.**

**SERVICE AND MAINTENANCE**

**THE CONTRACTOR SHALL PROVIDE A FIVE-YEAR EQUIPMENT HARDWARE WARRANTY OF THE INSTALLED SYSTEM AGAINST DEFECTS IN MATERIAL AND WORKMANSHIP. ALL MATERIALS SHALL BE PROVIDED AT NO EXPENSE TO THE OWNER DURING NORMAL WORKING HOURS. THE WARRANTY PERIOD SHALL BEGIN ON 1ST OF THE MONTH FOLLOWING THE DATE OF SHIPMENT.**

**THE CONTRACTOR SHALL, AT THE OWNER'S REQUEST, MAKE AVAILABLE A SERVICE CONTRACT OFFERING CONTINUING FACTORY AUTHORIZED SERVICE OF THIS SYSTEM AFTER THE INITIAL HARDWARE AND SOFTWARE WARRANTY PERIODS.**

**THE SYSTEM MANUFACTURER SHALL MAINTAIN ENGINEERING AND SERVICE DEPARTMENTS CAPABLE OF RENDERING ADVICE REGARDING INSTALLATION AND FINAL ADJUSTMENT OF THE SYSTEM.**

**PART 2 - SYSTEM SPECIFICATION**

**41.01 MANUFACTURERS**

**BOGEN NYQUIST E7000 SYSTEM (OWNERS PREFERRED SYSTEM)**

**TELECOR E--SERIES**

**VALCOM I/P**

**THE SPECIFYING AUTHORITY MUST APPROVE ANY ALTERNATIVE SYSTEM.**

**THE INTENT IS TO ESTABLISH A STANDARD OF QUALITY, FUNCTION, AND FEATURES. IT IS THE RESPONSIBILITY OF THE BIDDER TO ENSURE THAT THE PROPOSED PRODUCT MEETS OR EXCEEDS EVERY STANDARD SET FORTH IN THESE SPECIFICATIONS.**

**THE FUNCTIONS AND FEATURES SPECIFIED ARE VITAL TO THE OPERATION OF THIS FACILITY; THEREFORE, INCLUSION IN THE LIST OF ACCEPTABLE MANUFACTURERS DOES NOT RELEASE THE CONTRACTOR FROM STRICT COMPLIANCE WITH THE REQUIREMENTS OF THIS SPECIFICATION.**

**EQUIPMENT**

**NYQUIST NQ-E7030 ANALOG STATION BRIDGE**

**49.01 24 STATION SUPPORT**

**49.02 120W OF TOTAL AVAILABLE POWER; MAX. 40W PER ANY INDIVIDUAL PORT**

**49.03 25 VOLT SPEAKERS(S)**

**49.04 SOFTWARE PROGRAMMABLE CONFIGURATION AND OPERATION**

**49.05 RACK MOUNTED, WALL MOUNTED, OR SHELF MOUNTED**

**49.06 CAN BUS 2.0 INTERFACE FOR FUTURE SUPPORT FOR NQ-E7020 DCS**

**NYQUIST STATION EQUIPMENT**

**50.01 NQ-T1000 VOIP STAFF PHONE – LCD DISPLAY (AKA STAFF STATION)**

**50.02 CSD1X2UV DROP-IN CEILING SPEAKER**

**50.03 RECESSED ANALOG WALL SPEAKERS (INTERIOR AS SHOWN ON PLANS)**

**50.04 GYMNASIUM HORN SPEAKER (INTERIOR AS SHOWN ON PLANS)**

**OPTIONAL EQUIPMENT**

**51.01 TELEPHONY INTERFACE DEVICE(S) FOR FXO/FXS ANALOG PORT CONNECTIVITY**

**COMPONENTS AND DESCRIPTIONS**

- A The Nyquist E7000 Series Educational System is a software-based VoIP paging and intercom system.
- B The Nyquist E7000 Series Educational System must be capable of supporting existing Bogen Multicom 2000 and Bogen Quantum Multicom IP wiring, 25 volt speakers and analog call-switches, and equivalent competitive systems utilizing the existing architectural numbering scheme. The VoIP capabilities of the Nyquist system will enable the support of the features across the various Nyquist appliances within the facility. The following sections define how the system handles each of the features in the system. Systems that do not allow the reuse of existing wiring or numbering scheme shall not be deemed acceptable. Systems that do not allow appliances to be seamlessly integrated via the LAN are not considered equal.

**NYQUIST SERVER APPLICATION**

**53.01 THE NYQUIST SOFTWARE IS INSTALLED ONTO THE SERVER, AND UPON BOOT-UP, USERS CAN LOG IN TO THE NYQUIST SERVER APPLICATION VIA A WEB BROWSER THAT SUPPORTS WEBRTC. SYSTEMS THAT REQUIRE COM PORT REDIRECT SOFTWARE, CLIENT PC APPLICATION, SOFTWARE OR SERIAL-TO-ETHERNET ADAPTERS FOR USER ACCESS ARE NOT DEEMED EQUAL. COMMUNICATIONS BETWEEN THE SERVER AND THE WEB UI(S) SHALL BE VIA SECURE HYPER TEXT TRANSFER PROTOCOL (HTTPS) CONNECTIONS (I.E., HTTPS://).**

**53.02 THE NYQUIST WEB UI SHALL BE CONFIGURED WITH FOUR DIFFERENT DEFAULT USER ACCESS LEVELS, BASED ON FOUR UNIQUE USER ROLES. SYSTEMS THAT DO NOT PROVIDE UNLIMITED ACCESS LEVELS AND UNLIMITED USER ROLES ARE NOT CONSIDERED EQUAL.**

- A The four default roles shall be: admin, optech, operator, and user. These roles provide a starting point/example for administrators to create additional roles.

**53.03 ONLY A USER ASSIGNED THE ADMIN ROLE SHALL BE ABLE TO PROVIDE ACCESS TO USERS, GIVING THEM THE ABILITY TO CREATE, DELETE, EDIT, AND VIEW SYSTEM PARAMETERS.**

**53.04 ONLY AN ADMINISTRATOR SHALL HAVE THE ABILITY TO ADJUST ROLES AND CLASS OF SERVICE (COS) OF USERS. THE ROLES DETERMINE IF USERS CAN VIEW THE DEFINABLE DATA OBJECTS THAT CAN INCLUDE CONFIGURATION, ALARMS, AND PERFORMANCE DATA AND IF USERS CAN PERFORM CERTAIN OPERATIONS BASED ON THE USER'S ROLE AND STATION'S COS. ALL CHANGES TO ROLES AND COS ARE EFFECTIVE IMMEDIATELY, WITHOUT THE NEED TO RESTART THE BROWSER OR REBOOT THE SERVER.**

**53.05 THE NYQUIST WEB UI DASHBOARD SHALL PROVIDE FULL ADMINISTRATIVE CAPABILITIES TO MANAGE/OPERATE THE FOLLOWING SYSTEM FEATURES:**

- A Calling/Paging – User can initiate a call by accessing the directory or by dial pad and can receive calls, make Zone Page and All-Call Page, make a Prepending Page, Emergency All-Call paging.
- B Call Forwarding
- C District Calling/Paging – Used for District Facility Page, District All-Call, and District Emergency All-Call.
- D Tones/Announcements – Used to play Tones, Announcements, and Alarms.
- E View This Week's Schedule – Used to show the current interactive Bell Schedule.
- F Audio Distribution – Used for entire facility or Audio Zones
- G Enable or Disable Audio – Used to place the Nyquist system into Page Exclusion mode (i.e., "mute" the system) when a contact closure is supplied from the fire alarm panel. Systems that do not provide this capability are deemed not equal.
  - 1. Systems that require application software to be installed on a PC to manage the above features shall not be considered equivalent.

**53.06 TO FACILITATE INSTALLATION AND CONFIGURATION OF THE SYSTEM, ADDITIONAL WEB UI MENUS ARE REQUIRED. THE MENUS SHALL ONLY BE VISIBLE TO USERS WITH THE CORRECT ROLES AND COS. THE NAVIGATION MENUS FOUND ON THE WEB UI SHALL BE AS FOLLOWS:**

- A System Parameters – Allow installers to adjust core system parameters.
- B Zones – Allow installers to create and modify Paging, Time, and Audio Zones.
- C Schedules – Allow installers and administrators to create bell schedules for the facility, predefine alternative schedules to run, prevent the bells from ringing on a holiday, and schedule an announcement to play. The system shall allow an unlimited number of schedules to operate simultaneously within a facility.
- D Admin Groups – Allow the installer to create, modify, and delete software groupings of admin phones that can ring when a station calls in with a call switch.
- E CoS Configuration – Allow the installer to create, modify, and delete CoS groups that control station access to the following features: Call-in Level, Zone Paging, All-Call Paging, Emergency All-Call, Inter-Facility Call/Page, Audio Distribution, Remote Pickup, Join Conversation, Call Forwarding, Walking Class of Service, External Call Routing, Call Transfer/3-way Calling, Manually Activate Tone Signals, Call Any Station, Manage Recording, Monitor Calls, Monitor Locations, Conference Admin, Conference User, Voicemail, Record Calls, Activate Alarm Signals, Disable Audio, Enable Audio, Allow Callee Auto-answer, District Paging, and Inter-Facility Features.
- F Bridge Devices – Allow the installer to configure the Nyquist ASBs.
- G Audio – Allow the installer to upload and manage Announcements, Playlists, Songs, and Tones. The system must support the uploading of both MP3 and WAV files and make Audio file management simple for users. Systems that limit the size of Audio files shall not be considered equal.
- H Users – Allow the installer to manage users by giving them the proper roles and assign extensions if needed.
- I Roles – Allow the installer to grant users rights to Create, Delete, Edit, Restart Server, Sort Menu, Systems Update, Manage, Import/Export, Restore, Settings, or View.
- J Facilities – Allow the installer to set up the district wide facilities for remote paging and calling.
- K Outside Lines – Allow the installer to set up FXS and FXO ports for inbound and outbound system calling.
- L SIP Trunks – Allow the installer to set up SIP trunks into the facility for inbound or outbound calling.
- M Call Details – Allow the installer to review the historical system activities that can be used for incident investigation or system troubleshooting.
- N System Backup/Restore – Allow the installer to perform system backups or restores and allow the backups to be schedule to run automatically.
- O System Logs – Allow the installer to view and export Server, Nyquist-Intercom, and Web Server logs that can be used for troubleshooting and technical assistance.
- P Paging Exclusions – Allow the installer to view and edit stations that are excluded from paging.
- Q Firmware – Update firmware for Nyquist speakers and appliances.
- R Help – Provide information about the system, online help topics, and System Administrator Manual.
  1. .
- S Systems that do not provide these menus as a minimum shall not be considered equal.

**NYQUIST NQ-E7030 ANALOG STATION BRIDGE**

**54.01 THE NYQUIST NQ-E7030 ASB ALLOWS FACILITIES WITH EXISTING MULTICOM OR QUANTUM OR COMPATIBLE INTERCOM SYSTEMS TO UPGRADE TO NYQUIST. EACH ASB SUPPORTS UP TO 24 SPEAKERS AND CALL SWITCHES WITH 120 WATTS OF EMBEDDED 25 VOLT POWER. THE ASB IS DESIGNED TO DRIVE ANY COMBINATION OF 25 VOLT SPEAKERS AND HORNS. FEATURES INCLUDE:**

- A 10/100 Ethernet
- B 24 station interface - Supports connections to as many as 24 individual 25 Volt speakers with one 25 Volt speaker connection per interface
- C 24 dry contact closure-type analog Call Switch connections
- D Half-duplex talkback using speaker as pickup
- E CAN Bus 2.0 Interface for future NQ-E7020 DCS support and other accessory devices
- F 120W of available power across all 24 channels; maximum 40W per channel

- G 2 x RGB full spectrum LED status indicators
- H USB 2.0 host port, type A connector (future use)
- I Universal mains supply (100VAC – 240VAC)

**54.02 THE NYQUIST NQ-E7030 ASB SHALL BE RACK, WALL, OR SHELF MOUNTABLE AND SHALL INCLUDE THE REQUIRED MOUNTING BRACKET HARDWARE. CONTRACTOR SHALL PROVIDE AND INSTALL AS NEEDED.**

**NYQUIST NQ-T1000 STAFF VOIP PHONE – LCD DISPLAY (STAFF STATION)**

**55.01 NYQUIST STAFF STATION SHALL HAVE THE FOLLOWING FEATURES:**

- A 132 x 64-pixel graphical LCD with backlight
- B Two-port 10/100M Ethernet Switch
- C Full-duplex hands-free speakerphone with AEC
- D Call hold, mute
- E Redial, call return, auto answer
- F PoE (802.3af) Class-3 support
- G Dual-color (red or green) illuminated LEDs for line status information
- H Two 10/100M Ethernet ports
- I Wall or desk mountable

**55.02 THE CLASSROOM STAFF STATION SHALL BE CAPABLE OF THE FOLLOWING FEATURES DEPENDING ON HOW THE STATION COS IS CONFIGURED:**

- A Emergency intercom call – Staff Stations shall be capable of making an Emergency intercom call, which is then routed to the assigned Admin Station. This requires the display of the architectural number and call in level on the Admin Station. Systems that do not provide this feature are not equivalent.
- B Speed dial
- C Toggle audio distribution on and off
- D Call Forward activation and deactivation for All-Calls/Busy/No Answer/Busy or No Answer
- E Conference Calling
- F Transfer Call
- G Emergency All-Call – An emergency page shall be broadcasted to all the stations in the facility.
- H Place Outside Call
- I Remote Answer
- J Single-Zone/All-Station Page
- K Call Waiting Tone for Outside Calls – It shall be possible to feed the call waiting tone to the Administrative Phone during a conversation.
- L Transfer call from VoIP speaker in classroom down to an associated Staff Station
- M Transfer call from analog speaker in classroom down to an associated Staff Station
- N Transfer call from VoIP Staff Station in classroom up to an associated VoIP speaker
- O Transfer call from Staff Station in classroom up to an associated analog speaker

**NYQUIST NQ-S1810CT VOIP CEILING SPEAKER WITH TALKBACK AND NQ-S1810WT VOIP WALL BAFFLE SPEAKER WITH TALKBACK**

**56.01 THE VOIP SPEAKERS SHALL NOT REQUIRE TRADITIONAL INTERCOM WIRING OR TRANSFORMER TAPS TO MANUALLY SET OR ADJUST VOLUME. SIMPLY CONNECTING THEM VIA CAT 5 TO A POE SWITCH OR POE INJECTOR ON THE SYSTEM'S NETWORK SHOULD ALLOW THEM TO BE READY TO PROGRAM INTO THE SYSTEM. VOLUME IS CONTROLLED VIA THE NYQUIST WEB UI. ALL NYQUIST AUDIO APPLIANCES SHALL USE A WIDEBAND OPUS CODEC FOR AUDIO DISTRIBUTION. USE OF THE OPUS CODEC, ALONG WITH G.722, ALLOWS FOR HIGH DEFINITION AUDIO. NYQUIST VOIP SPEAKERS SHALL BE EQUIPPED WITH A DIGITAL MEMS MICROPHONE TO ACHIEVE SUPERIOR TALKBACK AUDIO. VOIP SPEAKERS THAT UTILIZE THE SPEAKER AS THE MICROPHONE SHALL NOT BE CONSIDERED EQUAL.**

**56.02 THE NQ-S1810WT VOIP WALL BAFFLE SPEAKER WITH TALKBACK DESIGN FACILITATES MOUNTING THE SPEAKER UP TO FOUR DIFFERENT WAYS:**

- A 2x2 Wall Mount

- B Box Mount
- C Corner Mount
- D Tilted Mount

**56.03 THE VOIP SPEAKERS PROVIDE CAN BUS 2.0 INTERFACE SUPPORT FOR THE NQ-E7020 DCS.**

**56.04 THE VOIP SPEAKERS SHALL BE POE IEEE 802.3AF COMPLIANT. VOIP SPEAKERS MAY BE PLACED UP TO 100 METERS (328 FEET) FROM A POE SWITCH OR POE INJECTOR.**

**56.05 SOFTWARE PROVIDES ADJUSTABLE AUDIO OUTPUT LEVEL.**

**56.06 DHCP WITH OPTION 66 IS SUPPORTED FOR EASY NETWORK DEPLOYMENT.**

**56.07 THE VOIP SPEAKERS PROVIDE VLAN SUPPORT.**

**56.08 THE VOIP SPEAKERS ARE PRE-ASSEMBLED FOR FASTER INSTALLATION.**

**56.09 EACH VOIP SPEAKER INCLUDES A10 WATT INTEGRATED POWER AMPLIFIER.**

**56.10 EACH VOIP SPEAKER HAS A DIGITAL MEMS MICROPHONE TO SUPPORT TALKBACK.**

**ADDITIONAL LOUDSPEAKERS FOR USE WITH THE NYQUIST ASB**

**57.01 CLASSROOM SPEAKERS SHALL BE BOGEN:**

- A Ceiling Mounted Speakers: CSD1X2U Drop-In Ceiling Speaker

**57.02 HALLWAY SPEAKERS SHALL BE BOGEN OR PRE-APPROVED EQUAL.:**

- A Ceiling Mounted Speakers: CSD1X2U Drop-In Ceiling Speaker
- B Wall Baffle Speakers: MB8TSQ/SL Metal Box Speaker

**57.03 OUTDOOR/GYM/LOCKER ROOM SPEAKERS SHALL BE BOGEN OR PRE-APPROVED EQUAL.:**

- A FMH15T mounted in BBSM6 surface-mounted vandal-resistant enclosure/BBFM6 flush-mounted vandal-resistant enclosure with FMHAR8 adapter ring and SGHD8 heavy duty grille
- B KFLDS30T Wide Dispersion Re-entrant Horn Loudspeakers

#### **SYSTEM CAPABILITIES**

**THE COMMUNICATION SYSTEM SHALL BE A BOGEN NYQUIST E7000 SERIES EDUCATIONAL SYSTEM OR PRE-APPROVED EQUAL AND SHALL PROVIDE A COMPREHENSIVE COMMUNICATIONS NETWORK BETWEEN ADMINISTRATIVE AREAS AND STAFF LOCATIONS THROUGHOUT THE FACILITY.**

**THE SYSTEM SHALL PROVIDE NO LESS THAN THE FOLLOWING FEATURES AND FUNCTIONS:**

**61.01 SOFTWARE-BASED, STATE-OF-THE-ART, VOICE OVER IP (VOIP) PAGING AND INTERCOM SOLUTION.**

**61.02 THE SYSTEM SHALL PROVIDE A WEB USER INTERFACE (WEB UI) SHALL ALLOW USERS TO CONFIGURE AND CONTROL THE SYSTEM, IN ACCORDANCE WITH THEIR ASSIGNED USER ROLE, FROM ANY WEB BROWSER ENABLED PC, MAC, ANDROID OR IOS TABLET OR MOBILE DEVICE.**

**61.03 AMPLIFIED-VOICE COMMUNICATION WITH ANALOG LOUDSPEAKERS SHALL USE A SHIELDED AUDIO PAIR WHEN CONNECTED TO AN ASB.**

**61.04 THE SYSTEM SHALL SUPPORT ANY COMBINATION OF THE FOLLOWING VOIP PHONE STATION TYPES: NQ-T1100 ADMINISTRATIVE VOIP PHONE – COLOR TOUCH DISPLAY (ADMIN STATION) OR NQ-T1000 STAFF VOIP PHONE – LCD DISPLAY (STAFF STATION).**

- A All VoIP phone station types shall utilize the same type of field wiring.
- B There shall be no limit to the number of Admin Stations that can be connected to a facility. Systems that require different head-end equipment to make Admin Stations function, or systems that limit the number of Admin or Staff Stations shall not be deemed acceptable.

- 61.05 FUTURE STATION ALTERATIONS SHALL ONLY REQUIRE THE STATION TYPE TO BE CHANGED IN SYSTEM PROGRAMMING. ALTERATIONS SHALL NOT REQUIRE FIELD WIRING OR SYSTEM HEAD-END ALTERATIONS, UNLESS AN ANALOG STATION DEVICE IS BEING REPLACED BY A VOIP STATION DEVICE OR VICE-VERSA.**
- 61.06 THE SYSTEM SHALL BE A GLOBAL NON-BLOCKING SYSTEM. THE SYSTEM SHALL BE CAPABLE OF UNLIMITED AMPLIFIED INTERCOM PATHS PER FACILITY. TWO AMPLIFIED INTERCOM PATHS SHALL BE PROVIDED WITH EACH ASB FOR ITS COMPLEMENT OF 24 STATIONS. ALL HARDWARE, ETC., REQUIRED TO ACHIEVE THE NECESSARY NUMBER OF AMPLIFIED-VOICE INTERCOM CHANNELS FOR THIS SYSTEM SHALL BE INCLUDED IN THIS SUBMITTAL. ASB AMPLIFIED-VOICE INTERCOM CHANNELS SHALL PROVIDE VOICE-ACTIVATED SWITCHING. SYSTEMS REQUIRING THE USE OF A PUSH-TO-TALK SWITCH ON ADMINISTRATIVE TELEPHONES SHALL NOT BE ACCEPTABLE. THERE SHALL BE AN AUTOMATIC LEVEL CONTROL FOR RETURN SPEECH DURING AMPLIFIED-VOICE COMMUNICATIONS. THE INTERCOM AMPLIFIER SHALL ALSO PROVIDE CONTROL OVER THE VOICE SWITCHING SENSITIVITY AND DELAY TIMES OF THE VOX CIRCUITRY ON THE ASB.**
- 61.07 THE SYSTEM SHALL PROVIDE 911 DIAL-THROUGH VIA OUTSIDE FXO/FXS LINES OR SIP TRUNKS TO ENSURE THAT ONE OR MORE LINES ARE ALWAYS AVAILABLE FOR 911 CALLS. THE 911 DIAL-THROUGH IS AVAILABLE TO ANY PROPERLY CONFIGURED STATION (VIA COS). WHEN A STATION DIALS 911, THE 911 CALL IS PROCESSED AS FOLLOWS:**
- A Call routes to an Emergency Group where the call can be answered.
  - B The 911 CO lines can be pre-configured and reserved. If the 911 reserved lines are busy, the normal CO lines will be connected to route the 911 calls. If all the normal CO lines are busy, then one of the ongoing calls shall be disconnected and the 911 call shall be placed.
  - C When 911 is dialed from any station, its designated Admin Station or Admin Group will receive a message that the station has dialed 911.
  - D The system shall automatically record all 911 calls made from any station. The 911 call recording shall begin as soon as 911 is dialed and shall continue until the call is terminated. Recorded calls shall be maintained on the system for later playback review and/or retrieval by authorized personnel and/or authorities.
- 61.08 IT IS OF HIGHEST IMPORTANCE THAT EMERGENCY CALLS FROM STATIONS RECEIVE PROMPT ATTENTION. THEREFORE, IT IS IMPORTANT THAT THERE BE AN ALTERNATIVE DESTINATION IN CASE THE EMERGENCY CALL DOES NOT GET ANSWERED AT THE PRIMARY LOCATION. DETAILS ARE AS FOLLOWS:**
- A Staff-generated Emergency calls shall be treated as the second highest system priority. Therefore, all Emergency calls shall annunciate at the top of the call queue of their respective Admin Station or Admin Group. Should that Emergency call go unanswered for 15 seconds, the call shall be re-routed to an alternative speaker station. Then, a tone will prompt the caller to make a verbal call for help and annunciates to the Emergency link station "Emergency." During the transfer, the original administrative telephone shall continue to ring the distinctive Emergency Ring. Should the Emergency Transfer-to-Station have an associated Admin Station, it will also ring for the Emergency call.
  - B The Emergency Transfer-to-Station shall be software configurable.
  - C Systems failing to transfer unanswered Emergency calls or failing to immediately connect to the designated Admin Station shall not be deemed as equal.
- 61.09 THERE SHALL BE A FACILITY WIDE EMERGENCY ALL-CALL FEATURE. THE EMERGENCY ALL-CALL SHALL BE ACCESSED FROM DESIGNATED ADMIN STATIONS OR THE NYQUIST DASHBOARD OR BY THE ACTIVATION OF AN EXTERNAL CONTACT CLOSURE THAT SHALL GIVE A MICROPHONE INPUT EMERGENCY STATUS. THE EMERGENCY ALL-CALL FUNCTION SHALL HAVE THE HIGHEST SYSTEM PRIORITY AND SHALL OVERRIDE ALL OTHER LOUDSPEAKER-RELATED FUNCTIONS INCLUDING TIME TONES, NORMAL ALL-CALL OR ZONE PAGES, OR AUDIO DISTRIBUTION.**
- A Considering that Emergency calls are to be treated with the highest level of concern, systems that do not regard Emergency All-Call with the highest priority shall not be deemed as equal.

- B Upon touching the Directory icon, a menu shall appear on the Admin Station display prompting the user to select the desired menu.
- C The Emergency All-Call shall capture the highest-level system priority and shall be transmitted over all speakers in the facility. It shall also be capable of activating an external control output, which can be used to activate external relays to automatically override volume controls, local sound systems, or strobe circuits.
- D Systems without Emergency All-Call or systems with All-Call that cannot be activated by external means or that do not capture complete system priority or activate an external relay, shall not be acceptable.

**61.10 EACH STATION LOUDSPEAKER SHALL BE ASSIGNABLE TO ALL OR ANY COMBINATION OF PAGING, TIME, AND/OR AUDIO ZONES. SYSTEMS THAT DO NOT PROVIDE UNLIMITED PAGING, TIME, AND/OR AUDIO ZONES SHALL NOT BE ACCEPTABLE.**

**61.11 THERE SHALL BE UNLIMITED SCHEDULES WITH UNLIMITED PROGRAMMABLE EVENTS PER FACILITY. EACH EVENT SHALL SOUND ONE USER-SELECTED TONE OR EXTERNAL AUDIO SOURCE. IT SHALL BE POSSIBLE TO ASSIGN EACH SCHEDULE TO A DAY OF THE WEEK OR TO MANUALLY CHANGE SCHEDULES FROM AN AUTHORIZED USER VIA A WEB-BASED UI. SYSTEMS THAT DO NOT PROVIDE UNLIMITED SCHEDULES, EVENTS, AND TONES, OR THAT REQUIRE SOFTWARE TO BE INSTALLED ON A PC TO PERFORM THESE FUNCTIONS SHALL NOT BE ACCEPTABLE.**

- A The system shall provide multiple concurrent schedules per facility/location to accommodate split facilities (for example., combined Elementary and Middle School, combined Middle and High School, etc.).
- B The system must be capable of providing Class Change Music to be played from an external audio source or audio files that are stored in playlists on the system during class change periods or whenever a facility wants music to be played in an area (i.e., (i.e., one or more Time Zones) on an automated schedule.
- C Each event shall be able to be directed to any one or more of the unlimited Time Zones.
- D Each of the unlimited Time Zones shall have a programmable, customizable Preannounce Tone and volume control that is unique unto itself.
- E Each event shall play any of the Normal tones or external audio. Each event may utilize a different tone. For example, the system shall be capable of sending the gymnasium, shop classes, and pool a separate, unique time tone to indicate "clean up." Minutes later, the entire facility can be sent a different time tone to indicate class change.
- F Each of the unlimited Time Tones may be manually activated by selected VoIP Admin Phones or via an authorized user with access to the Web UI. These tones shall remain active as long as the telephone remains off-hook or until canceled from the keypad or the Nyquist Web UI.
- G Systems that do not provide an unlimited number of schedules or do not provide automatic activation of schedules shall not be acceptable.

**61.12 THERE SHALL BE A ZONE PAGE/ALL-CALL PAGE FEATURE THAT IS ACCESSIBLE BY SELECTED ADMIN PHONES AND FXO/FXS OR SIP CONNECTION TO THE PSTN OR PBX/IPBX.**

**61.13 THERE SHALL BE AN OPTION TO PLAY A PRE-ANNOUNCE TONE AT ANY LOUDSPEAKER SELECTED FOR VOICE PAGING.**

**61.14 THERE SHALL BE A VOICE-INTERCOM FEATURE THAT IS ACCESSIBLE BY COS AUTHORIZED STAFF PHONES, ALL ADMIN VOIP PHONES, AND ADMIN WEB UIS.**

- A There shall be a privacy beep played every 15 seconds at any selected loudspeaker to indicate that an intercom call is in progress.
- B There shall be a pre-announce tone played at any selected loudspeaker for intercom call communication.
- C For special applications, the privacy and pre-announce tone signals shall be capable of being disabled during system initialization.
- D There shall be a switch over to private telephone communications should the person at the classroom loudspeaker pick up his or her Staff Station and dial \*3 to transfer the call down to the associated classroom Staff Station.

**61.15 THERE SHALL BE VARIOUS LEVELS OF TELEPHONIC COMMUNICATION ACCESSIBLE BY ALL ADMIN STATIONS AND STAFF STATIONS.**

- A Staff Stations must be capable of being programmed to ring one Admin Station during day hours and a different Admin Station during night hours. Day and Night start hours shall be configurable. Staff Stations

shall be capable of being assigned to any Admin station. Systems that limit the number and assignment of staff call-ins to an Admin Station shall not be acceptable.

**61.16 EACH VOIP SPEAKER OR ASB SPEAKER EQUIPPED WITH A CALL SWITCH (ANALOG OR DIGITAL) SHALL BE CONFIGURABLE AS ONE OF THREE CALL-IN TYPES, AS FOLLOWS:**

- A Normal/Emergency
- B Urgent/Emergency
- C Emergency

**61.17 IT SHALL BE POSSIBLE TO ANSWER ANY INCOMING CALL BY PICKING UP THE HANDSET WHILE IT IS RINGING. IT SHALL NOT BE NECESSARY TO PRESS ANY BUTTONS TO ANSWER A CALL UNLESS THE CALL HAS DROPPED INTO THE QUEUE.**

**61.18 STAFF STATIONS**

- A Staff Stations shall receive a dial tone upon going off-hook. Outgoing calls are made by dialing the desired station. Incoming calls can be directed to the telephone or to the associated loudspeaker for a hands-free reply. There shall be a switchover from loudspeaker to private telephone communication when a person picks up the handset, dials \*3, and presses Enter/OK.
- B Staff Stations shall be programmable for any type of system access, provided by or restricted by the following CoS options:
  - C Call-in Level
  - D Zone Paging
  - E All-Call Paging
  - F Emergency All-Call
  - G Inter-Facility Call/Page
  - H Audio Distribution
  - I Remote Pickup
  - J Join Conversation
  - K Call Forwarding
  - L Walking Class of Service
  - M External Call Routing
  - N Call Transfer/3-way Calling
  - O Manually Activate Tone Signals
  - P Call Any Station
  - Q Manage Recordings
  - R Monitor Calls
  - S Monitor Locations
  - T Conference Admin
  - U Conference User
  - V Voicemail
  - W Record Calls
  - X Activate Alarm Signals
  - Y Disable Audio
  - Z Enable Audio
- AA Allow Callee Auto-answer
- BB District Paging
- CC Inter-Facility Features
- DD Manage Output Contacts
- EE Staff Stations shall be able to make a Normal call to any Admin Station by dialing the Admin Station's extension number. Staff Stations shall also be able to initiate an Emergency Call by dialing \*\*\*\*. Emergency Calls shall ring the Designated Day/Night Admin Station. The system shall provide for each station to have a Personal Identification Number (PIN). By dialing the PIN at any system telephone, the administrator shall have access to Emergency paging regardless of the restrictions on the particular phone being used.



**61.19 SYSTEM PROGRAMMING SHALL BE FROM AN AUTHORIZED NYQUIST ADMIN USER VIA ANY WEB BROWSER. A VALID USERNAME AND PASSWORD SHALL BE REQUIRED TO GAIN ACCESS TO THE FOLLOWING PROGRAMMABLE FUNCTIONS:**

- A System Parameters – Allow installers to adjust core system parameters.
- B Zones – Allow installers to create and modify Paging, Time, and Audio Zones.
- C Schedules – Allow installers and administrators to create Bell Schedules for the facility, predefine alternative schedules to run. Holiday Events prevent the bells from ringing on a school holiday. The system shall allow an unlimited number of schedules to operate simultaneous within a facility.
- D Admin Groups – Allow the installer to create, modify, and delete software groupings of admin phones that can ring when a station calls in with a call switch.
- E CoS Configuration – Allow the installer to create, modify, and delete CoS groups that can have the following features defined: Call in Level, Zone Paging, All-Call Paging, Emergency All-Call, Inter-Facility Call/Page, Audio Distribution, Remote Pickup, Join Conversation, Call Forwarding, Walking Class of Service, External Call Routing, Call Transfer/3-way Calling, Manually Activate Tone Signals, Call any Station, Manage Recording, Monitor Calls, Monitor Locations, Conference Admin, Conference User, Voicemail, Record Calls, Activate Alarm Signals, Disable Audio, Enable Audio, Allow Callee Auto-answer, District Paging, and Inter-Facility Features.
- F Stations – Allow the installer to set up, modify, delete stations, set up Page Exclusion, view stations' status, and add a station.
- G Bridge Devices – Allow the installer to install the Nyquist ASBs.
- H Audio – Allow the installer to upload and manage Announcements, Playlists, Announcements, Songs, and Tones. The must support the uploading of both MP3 and WAV files making Audio file management simple for users. Systems that limit the size of Audio files shall not be considered equal.
- I Users – Allow the installer to manage users by giving them the proper Role and assign an Extension if needed.
- J Roles – Allow the installer to limit user to the following: create, delete, edit, restart server, sort menu, systems update, manage, import/export, restore, settings, or view.
- K Facilities – Allow the installer to set up the district wide facilities for remote paging and calling.
- L Outside Line – allow the installer to set up FXS and FXO ports for inbound and outbound system calling.
- M SIP Trunks – allow the installer to set up SIP trunks into the facility for inbound or outbound calling.
- N Call Details – allow the installer to review the historical system activities that can be used for incident investigation or system troubleshooting.
- O System Backup/Restore – allow the installer to preform system backup or restores and allow the backups to be schedule to run automatically.
- P System Logs – allow the installer to view and export Server, Nyquist-Intercom, and Web Server logs that can be used for trouble shooting and technical assistance.
- Q Paging Exclusions – allow the installer to view and edit station that are excluded from paging.
- R Firmware – is used to update Nyquist appliances.
- S Help –Provides information about the system, online help topics, and System Administrator Manual.
- T Systems not capable of supporting web-based configuration and control, or require plugins or dedicated application software, shall not be deemed as equal.
- U Systems that require a Serial-to-Ethernet converter, or require additional application software on a PC for configuration and/or control shall not be deemed as equal.

**61.20 ADMIN GROUP**

- A Admin Stations can be placed into Admin Groups, which are used if incoming calls are not answered by the assigned Admin Station or the Day or Night Admin associated with the Admin Station. Admin Groups act as an always answer feature by providing an alternate list of Admin Stations. If an incoming call is not answered by the assigned Admin Station within 30 seconds for normal calls or 15 seconds for emergency calls, all Admin Stations in the Admin Group will ring.
- B If Call Forwarding is enabled at the Admin Station, Nyquist tries the forwarded extension. If that station does not answer or is busy, the call timeout is reduced to 15 seconds. After 15 seconds, the call rolls over to the Admin Group.

- C If an Emergency level call receives no answer, the Admin Group will ring if the Day Admin or Night Admin does not answer.
- D Admin Stations can be assigned to multiple Admin Groups. A Day or Night Admin can also be assigned to one or more Admin Groups.

**61.21 CALL DETAIL REPORTING**

- A The Call Details feature allows the viewing and/or printing of detail records of every call in a facility in a call log format. Calls include scheduled announcements, paging, and internally and externally made or received telephone calls.

**61.22 SYSTEM BACKUP/RESTORE**

- A The system backup feature allows users with access to back up the system database, voicemail, and recordings.
- B The system restore allows users with access to perform a system restore of previously backed up database, voicemail, and/or recordings.
- C The installer also can set up an automatic backup that can be performed daily, weekly, or monthly.

**61.23 SYSTEM LOG FILES**

- A A log file records either events or messages that occur when software runs and is used when troubleshooting the system. The following parts of the Nyquist system generate log files:
  1. Server (This provides access to the Debian Linux OS server log files.)
  2. Intercom (This provides access to the Intercom application server log files.)
  3. Web Server (This provides access to the web server log files.)
- B From the web-based UI, system logs can be viewed directly or exported via download to a PC, Mac, or Android device and then copied to removable media or attached to an email to technical support.

**61.24 PAGING EXCLUSIONS**

- A For school testing and exams, the administrators shall be able to put stations into Page Exclusion mode. During this time, the stations will only receive Emergency All-Call pages – not music, tones, or All-Calls. Emergency pages will still be heard at the station even if that station is set to exclude paging.

**PART 3 - EXECUTION**

**62.01 EXAMINATION**

**EXAMINE CONDITIONS, WITH THE INSTALLER PRESENT, FOR COMPLIANCE WITH REQUIREMENTS AND OTHER CONDITIONS AFFECTING THE PERFORMANCE OF THE NYQUIST E7000 SERIES EDUCATIONAL SYSTEM.**

**DO NOT PROCEED UNTIL UNSATISFACTORY CONDITIONS HAVE BEEN CORRECTED.**

**EQUIPMENT MANUFACTURER'S REPRESENTATIVE**

**ALL WORK DESCRIBED HEREIN TO BE DONE BY THE MANUFACTURER'S AUTHORIZED REPRESENTATIVE SHALL BE PROVIDED BY A DOCUMENTED FACTORY AUTHORIZED REPRESENTATIVE OF THE BASIC LINE OF EQUIPMENT TO BE UTILIZED.**

**AS FURTHER QUALIFICATION FOR BIDDING AND PARTICIPATING IN THE WORK UNDER THIS SPECIFICATION, THE MANUFACTURER'S REPRESENTATIVE SHALL HOLD A VALID C-10 CONTRACTOR'S LICENSE ISSUED BY THE CONTRACTOR'S STATE LICENSE BOARD OF [YOUR STATE]. THE MANUFACTURER'S REPRESENTATIVE SHALL HAVE COMPLETED AT LEAST 10 PROJECTS OF EQUAL SCOPE, GIVING SATISFACTORY PERFORMANCE, AND SHALL HAVE BEEN IN THE BUSINESS OF FURNISHING AND INSTALLING SOUND SYSTEMS OF THIS TYPE FOR AT LEAST FIVE YEARS. THE MANUFACTURER'S REPRESENTATIVE SHALL BE CAPABLE OF BEING BONDED TO ENSURE THE OWNER OF PERFORMANCE AND SATISFACTORY SERVICE DURING THE GUARANTEE PERIOD.**

**THE MANUFACTURER'S REPRESENTATIVE SHALL PROVIDE A LETTER WITH SUBMITTALS FROM THE MANUFACTURER OF ALL MAJOR EQUIPMENT STATING THAT THE MANUFACTURER'S REPRESENTATIVE IS AN AUTHORIZED DISTRIBUTOR. THIS LETTER SHALL ALSO STATE THAT THE MANUFACTURER GUARANTEES SERVICE PERFORMANCE FOR THE LIFE OF THE EQUIPMENT AND THAT THERE WILL ALWAYS BE AN AUTHORIZED DISTRIBUTOR ASSIGNED TO SERVICE THE AREA IN WHICH THE SYSTEM HAS BEEN INSTALLED.**

**THE CONTRACTOR SHALL FURNISH A LETTER FROM THE MANUFACTURER OF THE EQUIPMENT. THIS LETTER SHALL CERTIFY THAT THE EQUIPMENT HAS BEEN INSTALLED ACCORDING TO FACTORY INTENDED PRACTICES, THAT ALL THE COMPONENTS USED IN THE SYSTEM ARE COMPATIBLE, AND THAT ALL NEW PORTIONS OF THE SYSTEMS ARE OPERATING SATISFACTORILY. FURTHER, THE CONTRACTOR SHALL FURNISH A WRITTEN UNCONDITIONAL GUARANTEE, GUARANTEEING ALL PARTS AND ALL LABOR FOR A PERIOD OF FIVE YEARS AFTER FINAL ACCEPTANCE OF THE PROJECT BY THE OWNER.**

**DIVISION OF WORK**

**WHILE ALL WORK INCLUDED UNDER THIS SPECIFICATION IS THE COMPLETE RESPONSIBILITY OF THE CONTRACTOR, THE FOLLOWING DIVISION OF ACTUAL WORK LISTED SHALL OCCUR:**

**71.01 THE CONDUIT, OUTLETS, TERMINAL CABINETS, ETC., WHICH FORM PART OF THE ROUGH-IN WORK, SHALL BE FURNISHED AND INSTALLED COMPLETELY BY THE DIVISION 26 ELECTRICAL CONTRACTOR.**

**71.02 THE BALANCE OF THE SYSTEM, INCLUDING INSTALLATION OF SPEAKERS AND EQUIPMENT, MAKING ALL CONNECTIONS, ETC., SHALL BE PERFORMED BY THE MANUFACTURER'S AUTHORIZED REPRESENTATIVE. THE ENTIRE RESPONSIBILITY OF THE SYSTEM, ITS OPERATION, FUNCTION, TESTING AND COMPLETE MAINTENANCE FOR ONE (1) YEAR AFTER FINAL ACCEPTANCE OF THE PROJECT BY THE OWNER, SHALL ALSO BE THE RESPONSIBILITY OF THE MANUFACTURER'S AUTHORIZED REPRESENTATIVE..**

**INSTALLATION**

**THE INSTALLATION, ADJUSTMENT, TESTING, AND FINAL CONNECTION OF ALL CONDUIT, WIRING, BOXES, CABINETS, ETC., SHALL CONFORM TO LOCAL ELECTRICAL REQUIREMENTS AND SHALL BE SIZED AND INSTALLED IN ACCORDANCE WITH THE MANUFACTURER'S APPROVED SHOP DRAWINGS.**

**LOW-VOLTAGE WIRING SHALL BE PLENUM RATED AND MAY BE RUN EXPOSED SUPPORTED VIA CABLE TRAY AND OR PLENUM RATED J-HOOK SUPPORTS ABOVE CEILING AREAS WHERE THEY ARE EASILY ACCESSIBLE.**

**THE CONTRACTOR SHALL INSTALL THE NEW SYSTEM AT THE LOCATION SHOWN ON THE PLANS.**

**ALL STAFF STATIONS SHALL BE WALL-MOUNTED IN CLASSROOMS:**

**76.01 MOUNT AT 48" AFF. TO TOP OF OUTLET BOX.**

**76.02 ALL DATA CAT-6 CABLING FOR SIP PHONES SHALL BE BY DIVISION 27 STRUCTURED WIRING CONTRACTOR UNDER SPECIFICATION 2710000 THIS WIRING SHALL BE CONCEALED.**

**ADMIN STATIONS CAN BE DESK OR WALL MOUNTED.**

**SPEAKER AND TELEPHONE LINES RUN ABOVE CEILING AND NOT IN CONDUIT SHALL BE TIE-WRAPPED TO A CEILING JOIST WITH A MAXIMUM SPACING OF 8' BETWEEN SUPPORTS. NO WIRES SHALL BE LAID ON TOP OF CEILING TILE.**

**CONNECT FIELD CABLE TO EACH ANALOG SPEAKER TRANSFORMER USING UL BUTT SPLICES FOR #22 AWG WIRE.**

**CONTRACTOR SHALL PROVIDE A MINIMUM OF EIGHT HOURS OF CONFIGURATION AND OPERATIONAL INSTRUCTION TO SCHOOL PERSONNEL.**

**80.01 BOGEN COMMUNICATIONS, INC., SHALL PROVIDE ONLINE "HOW TO" VIDEOS FOR INSTRUCTING THE TEACHING STAFF ON HOW TO OPERATE THE TEACHER DASHBOARD ASPECT OF THE SYSTEM.**

**ON THE FIRST SCHOOL DAY FOLLOWING INSTALLATION OF THE NYQUIST SYSTEM, THE CONTRACTOR SHALL PROVIDE A TECHNICIAN TO STAND BY AND ASSIST IN SYSTEM OPERATION.**

**MARK AND LABEL ALL DEMARKS IDF AND MDF POINTS WITH DESTINATION POINT NUMBERS. ROOMS WITH MORE THAN ONE OUTLET SHALL BE MARKED XXX-1, XXX-2, XXX-3, ETC. WHERE XXX IS THE ROOM NUMBER.**

**NO GRAPHIC ROOM NUMBER SHALL EXCEED THE SEQUENCE FROM 000001 THROUGH 899999.**

**83.01 ALL OUTSIDE SPEAKERS SHALL BE ON A SEPARATE PAGE ZONE AND TIME ZONE.**

**83.02 ALL ZONES SHALL BE LAID OUT NOT TO EXCEED 40 WATTS (@25V) MAXIMUM PER ZONE.**

**83.03 ALL HALLWAY SPEAKERS SHALL BE TAPPED AT 1 WATT (@25V) MAXIMUM.**

**83.04 ALL OUTSIDE HORNS SHALL BE TAPPED AT 3.75 WATTS (@25V) MAXIMUM.**

**83.05 ALL CLASSROOM SPEAKERS SHALL BE TAPPED AT ½ WATT (@25V) MAXIMUM.**

**83.06 LARGE ROOMS, SUCH AS GYMNASIUM, SHALL BE TAPPED AT 2 WATTS (@25V) MAXIMUM.**

**PLUG DISCONNECT: ALL MAJOR EQUIPMENT COMPONENTS SHALL BE FULLY PLUGGABLE BY MEANS OF MULTI-PIN RECEPTACLES AND MATCHING PLUGS TO PROVIDE FOR EASE OF MAINTENANCE AND SERVICE.**

**PROTECTION OF CABLES: CABLES WITHIN TERMINAL CABINETS, EQUIPMENT RACKS, ETC., SHALL BE GROUPED AND BUNDLED (HARNESSED) AS TO TYPE AND LACED WITH NO. 12 CORD WAXED LINEN LACING TWINE OR T AND B WIRE-TIES, OR HOOK AND LOOP CABLE MANAGEMENT. EDGE PROTECTION MATERIAL SHALL BE INSTALLED ON EDGES OF HOLES, LIPS OF DUCTS, OR ANY OTHER POINT WHERE CABLES OR HARNESSES CROSS A METALLIC EDGE.**

**CABLE IDENTIFICATION: CABLE CONDUCTORS SHALL BE COLOR-CODED AND INDIVIDUAL CABLES SHALL BE INDIVIDUALLY IDENTIFIED. EACH CABLE IDENTIFICATION SHALL HAVE A UNIQUE NUMBER LOCATED APPROXIMATELY 1-1/2" FROM CABLE CONNECTION AT BOTH ENDS OF CABLE. NUMBERS SHALL BE APPROXIMATELY 1/4" IN HEIGHT. THESE UNIQUE NUMBERS SHALL APPEAR ON THE AS-BUILT DRAWINGS.**

**SHIELDING: CABLE SHIELDING SHALL BE CAPABLE OF BEING CONNECTED TO COMMON GROUND AT POINT OF LOWEST AUDIO LEVEL AND SHALL BE FREE FROM GROUND AT ANY OTHER POINT. CABLE SHIELDS SHALL BE TERMINATED IN THE SAME MANNER AS CONDUCTORS.**

**PROVIDE COMPLETE "IN SERVICE" INSTRUCTIONS OF SYSTEM OPERATION TO SCHOOL PERSONNEL. ASSIST IN PROGRAMMING OF TELEPHONE SYSTEM.**

**GROUNDING**

**THE CONTRACTOR SHALL PROVIDE EQUIPMENT GROUNDING CONNECTIONS FOR INTEGRATED TELECOMMUNICATIONS/TIME/AUDIO/MEDIA SYSTEM AS INDICATED. TIGHTEN CONNECTIONS TO COMPLY WITH TIGHTENING TORQUES SPECIFIED IN UL STANDARD 486A TO ENSURE PERMANENT AND EFFECTIVE GROUNDS.**

**THE CONTRACTOR SHALL PROVIDE GROUND EQUIPMENT, CONDUCTOR, AND CABLE SHIELDS TO ELIMINATE SHOCK HAZARD AND TO MINIMIZE THE GREATEST EXTENT POSSIBLE, GROUND LOOPS, COMMON MODE RETURNS, NOISE PICKUP, CROSS TALK, AND OTHER IMPAIRMENTS.**

**THE CONTRACTOR SHALL PROVIDE ALL NECESSARY TRANSIENT PROTECTION ON THE AC POWER FEED AND ON ALL STATION LINES LEAVING OR ENTERING THE BUILDING.**

**THE CONTRACTOR SHALL NOTE ON THEIR DRAWINGS THE TYPE AND LOCATIONS OF THESE PROTECTION DEVICES AND ALL WIRING INFORMATION.**

**THE CONTRACTOR SHALL FURNISH AND INSTALL A DEDICATED, ISOLATED EARTH GROUND FROM THE CENTRAL EQUIPMENT RACK AND BOND TO THE INCOMING ELECTRICAL SERVICE GROUND BUSS BAR.**

**DOCUMENTATION**

**PROVIDE THE FOLLOWING DIRECTLY TO THE SUPERVISOR OF TECHNOLOGY SERVICES.**

**ONE PRINTED COPY OF ALL FIELD PROGRAMMING FOR ALL COMPONENTS IN SYSTEM**

**ONE COPY OF ALL DIAGNOSTIC SOFTWARE WITH A COPY OF FIELD PROGRAMMING DATA FOR EACH UNIT**

**ONE COPY OF ALL FIELD WIRING RUNS, LOCATION, AND END DESIGNATION OF SYSTEM**

**PROVIDE ONE COPY OF ALL SERVICE MANUALS, PARTS LIST, AND INTERNAL WIRING DIAGRAMS OF EACH COMPONENT OF SYSTEM.**

**SECTION 28 10 01**  
**ACCESS CONTROL**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A Access control panel.
- B Access control devices.
- C Accessory devices.

**1.02 RELATED SECTIONS**

- A Section 26 05 19 - Wires and Cables

**1.03 REFERENCES**

- A NFPA 70 - National Electrical Code 2020.
- B NFPA 72H - Guide for Test Procedures for Protective Signaling Systems.
- C NFPA 730 - Guide for Premises Security

**1.04 SYSTEM DESCRIPTION**

- A Access Control System: Expand the existing S2 Security Access Control System to new access controlled doors. Refer to plans for door locations. System includes: door controllers, power supplies ( by door hardware contractor), card readers, and all accessories and wiring required for a complete system. All access control components associated with door hardware shall be furnished and installed by the Access Control Contractor. Close coordination shall occur prior to any rough-in. A Pre-Installation Meeting shall occur prior to any work commencing.

**1.05 SUBMITTALS**

- A Submit under provisions of Division 1.
- B Shop Drawings: Indicate system wiring diagram showing each device and wiring connection required.
- C Product Data: Provide electrical characteristics and connection requirements.
- D Test Reports: Indicate satisfactory completion of required tests and inspections.
- E Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.
- F Protection Plan: Indicate doors with readers and device locations on floor plan for approval by Owner.

**1.06 PROJECT RECORD DOCUMENTS**

- A Submit under provisions of Division 1.
- B Record actual locations of all devices and path of wiring.

**1.07 OPERATION AND MAINTENANCE DATA**

- A Submit under provisions of Division 1.
- B Operation Data: Operating instructions.
- C Maintenance Data: Maintenance and repair procedures.

**1.08 QUALIFICATIONS**

- A Electrical Contractor shall employ an alarm system subcontractor that is licensed in the State of North Carolina and who specializes in installation of Products specified in this section with minimum five years' experience, and with service facilities within one hour of Project so as to provide prompt service.

**1.09 REGULATORY REQUIREMENTS**

- A Conform to requirements of NFPA 70.
- B Furnish Products listed and classified by UL or other third party testing agency recognized by The State of North Carolina as suitable for purpose specified and indicated.
- C Architects Section 01 23 00, The preferred OCSS Access Control System is manufactured by S2 Netbox.

**PART 2 PRODUCTS**

**2.01 ACCESS CONTROL HARDWARE**

- A Provide S2 Security Netbox Access Control Solution with up to 32 doors of access control. Provide additional S2 Network Nodes where needed to accommodate additional access controlled doors.
- B The S2 system shall be fully integrated and connected to the OCSS S2 Global ACS for centralized administration of card holder records.
- C Provide power supplies to match all electric door hardware. See door hardware specifications.

- D Provide HID Multiclass Mini-Mullion contactless card readers P/N #S2900PTNNEK0060-S2SEC or approved equal.
- E All doors shall have:
  - 1. REX Motion (Request to Exit Motion Sensor) Takex PU-PS520W or Honeywell CK-I5310WH.
  - 2. Door Position Switch (internal mount) GE Magnetics Series 1078, 1" diameter or equal.
- F Cards provided by OCSS.
- G Wiring as required by manufacturer, shielded stranded, (plenum type).
- H Wiring interconnection to network switch by Access Control contractor.

### **PART 3 EXECUTION**

#### **3.01 INSTALLATION**

- A A pre-installation meeting with Owner, Engineer and Contractors is required prior to installation of system.
- B Install in accordance with manufacturer's instructions.
- C Contractor to coordinate with OCSS and the OCSS S2 Global Contractor for proper programming of the S2 system and connection to the OCSS S2 Global system.
- D Obtain account code and card start number from OCSS security shop prior to programming.
- E Use plenum 4c#22-4 minimum size for data and signaling circuits.
- F Use plenum 2c#18-2E to power motion detectors from power supplies.
- G Access control panel shall be surface mounted 5' above finished floor.
- H All conductors entering into control panel or component boxes shall be concealed in ¾" or 1" conduits. Conduits will be accessible to ceiling voids. All control panels shall have a minimum of two (2) conduits for cabling entering panel. No exposed conductors will be permitted at the panel or at any instrument box where field wiring, i.e. power supplies, transformers and other devices, terminate into an instrument box.
- I Install all cables in permanent raceways within walls and inaccessible spaces. Support low voltage cables in accessible ceilings with J-Hooks. Cables shall be supported directly by the building structure. Bridle rings with saddles are also acceptable for cable supports attached to down rods or the ceiling cross beams. Do not use wire to support the J-Hooks or bridle rings. Route all low voltage cable in accordance with NEC. Use nylon bushings at ends of conduits.
- J All 120V power supply wiring shall be in conduit. Coordinate locations with the electrical contractor.
- K OCSS does not want door supplies above door locations. Therefore, locate at nearest Network closet. Coordinate locations with electrical contractor for 120V AC to power supply.
- L No splices shall be permitted at any point in the system.

#### **3.02 SYSTEM TESTING AND CERTIFICATION**

- A Upon completion of the Access Control and Video Intercom systems, OCSS Security and Contractors shall together test each and every initiating device for proper response and annunciation.
- B After successful completion of inspections and tests, the warranty begins. In the event of malfunctions or excessive false alarms, the Contractor must take prompt corrective actions. The Owner may require a repeat of the Contractor's 100% system test or other inspections. Continued improper performance during the warranty period shall be cause to require the Contractor to remove the system.

**END OF SECTION 281301 28 10 01**

**SECTION 28 23 00.01**  
**CCTV VIDEO MGMT**

**PART 1 GENERAL**

**1.01 GENERAL REQUIREMENTS**

- A The surveillance software shall be of manufacturer's official product line, designed for commercial and industrial use. OCSS Preferred Manufacturer is: Panasonic, See Architects Alternate Specification 012300.
- B The CCTV surveillance system shall be IP cameras connected to POE switches via the local area network (LAN). Cameras shall be provided and installed by the CCTV Security Contracto. POE network switches and video server shall be owner provided and owner installed. Please note, Cat-6 Plenum rated Camera cabling for the cameras shall be provided, installed and tested per BICSI standards by the Division 27 Structured Wiring Contractor. Close coordination shall take place between the CCTV Security contractor and the Structured Wiring contractor for a complete and operational system.

**1.02 QUALITY ASSURANCE**

- A The CCTV camera installation shall be performed by electronic technicians thoroughly trained by the manufacturer in the installation and service of the components.
- B Electrical Contractor shall employ a subcontractor that is licensed in the State of North Carolina and who specializes in installation of products specified in this section with a minimum five years experience, and with service facilities within one hour of the project so as to provide prompt service.

**1.03 REGULATORY REQUIREMENTS**

- A Conform to the requirements of 2020 NFPA 70.
- B Furnish products listed and classified by UL or other third party testing agency recognized by the State of North Carolina as suitable for purpose specified and indicated.

**1.04 RELATED SECTIONS**

- A 26 05 19 - Power Conductors and Cables
- B 27 10 00 - Telephone/Data Systems

**1.05 CERTIFICATIONS AND STANDARDS**

- A The surveillance at minimum shall comply with the following approvals:
  - 1. Section 508 - Accessibility Act
  - 2. FDCC - Federal Desktop Core Configuration
  - 3. NFPA 70 - 2020 National Electric Code
  - 4. NFPA 72H - Guide for Test Procedures for Protective Signalling Systems
  - 5. NFPA 731 - Installation of Electronic Premises Security Systems
  - 6. NFPA 730 - Guide for Premises Security

**1.06 SUBMITTALS:**

- A Permits: The Contractor shall obtain all required permits and provide copies to the Owner/Architect/Engineer
- B Product Literature: Complete manufacturer's product literature for all electronics, cable, cable supports, cable labels, outlet devices, and other products to be used in the installation. In addition, include instructions for storage, handling, protection, examination, preparation, and starting of product. whenever substitutions for recommended products are made, samples (when requested by the Owner/Architect/Engineer) and the manufacturer's supporting documentation demonstrating compatibility with other related products shall be included.
- C A complete floor plan diagram indicating camera locations and model numbers shall be required as part of the submittal.

**PART 2 PRODUCTS**

**2.01 GENERAL (CAMERA SCHEDULE- REFER TO ELECTRICAL PLANS)**

**2.02 PROJECT RECORD DOCUMENTS**

- A Submit under provisions of Division 1.
- B Record final as-built locations of all cameras.

**2.03 OPERATION AND MAINTENANCE DATA**

- A Submit under provisions of Division 1.
- B Operation Data: Operaing Instructions.



C Maintenance Data: Maintenance and repair procedures.

**PART 3 EXECUTION**

**3.01 INSTALLATION**

- A The Contractor shall carefully follow instructions in documentation provided by the manufacturer to insure all steps have been taken to provide a reliable, easy-to-operate system.
- B All software shall be tested and configured in accordance with instructions provided by the manufacturer prior to installation.
- C All software products shall be the latest versions and most up-to-date builds provided by the manufacturer.
- D All equipment requiring users to log on using a password shall be configured with user/site-specific password/passwords. No system/product default passwords shall be allowed.
- E Exterior cameras: Provide an exterior 4x4 gang box for all exterior cameras. The exterior camera can be mounted on surface plate of the gang box. All connections will be made inside box. Provide plastic bushings or insulated throat connectors shall be used in all conduit terminations. Conduits are not required in ceilings for CCTV Systems. Provide plenum rated cables where required.
- F Interior Cameras: Wire cameras to closest IDF room, coordinate installation with OCSS Security Shop maintenance technician.

**END OF DOCUMENT**

**SECTION 28 31 12**  
**INTRUSION DETECTION SYSTEM**

**PART 1 GENERAL**

**1.01 SUMMARY**

- A The Intrusion Detection system specified herein shall be provided and installed by the contractor as part of the base. Bid. OCSS will not provide any equipment for this system.
- B The electrical contractor shall provide all conduit, boxes and 120V AC wiring.
- C The licensed low-voltage security contractor shall provide and install panel, key-pads, zone modules, low voltage wiring, devices and any accessory items including making final connections and testing for a complete system.
- D The existing Napco Security System shall be expanded to the new/renovated areas.

**1.02 RELATED SECTIONS**

- A Section 26 05 19 - Wires and Cables

**1.03 REFERENCES**

- A NFPA 70 - National Electrical Code 2020.
- B NFPA 72H - Guide for Test Procedures for Protective Signaling Systems.
- C NFPA 730 -Guide for Premises Security.
- D Architects Alternate Section 01 23 00. The OCSS preferred system is a GEMINI / NAPCO Integrated Control Communicator.

**1.04 SYSTEM DESCRIPTION**

- A Intrusion Detection System: Protect building and selected areas from intrusion during secure hours.
- B System shall be an integrated control/communicator for monitoring status of detection devices and communicating via dedicated telephone lines to multiple telephone numbers using two programmable reporting formats.
- C The School shall be partitioned into separate protected areas as directed by OCSS Security.
- D System capacity shall be such that every motion sensor is individually zoned and signal from fire alarm panel separately zoned.
- E All equipment shall be provided by the Electrical and Security Contractors. No equipment will be provided by OCSS.

**1.05 SUBMITTALS**

- A Submit under provisions of Division 1.
- B Shop Drawings: Indicate system wiring diagram showing each device and wiring connection required.
- C Product Data: Provide electrical characteristics and connection requirements.
- D Test Reports: Indicate satisfactory completion of required tests and inspections.
- E Manufacturers Installation Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.
- F Protection Plan: Indicate building protection areas and device locations on floor plan for approval by Owner.

**1.06 PROJECT RECORD DOCUMENTS**

- A Submit under provisions of Division 1.
- B Record actual locations of initiating devices, signaling appliances, and end-of-line devices.
- C The program and all zone information will be turned over to OCSS security department.

**1.07 OPERATION AND MAINTENANCE DATA**

- A Submit under provisions of Division 1.
- B Operation Data: Operating instructions.
- C Maintenance Data: Maintenance and repair procedures.

**1.08 QUALIFICATIONS**

- A Electrical Contractor shall employ an alarm system subcontractor that is licensed in the State of North Carolina and who specializes in installation of Products specified in this section with minimum five years experience, and with service facilities within 60 miles of Project site.

**1.09 REGULATORY REQUIREMENTS**

- A Conform to requirements of NFPA 70.

- B Furnish Products listed and classified by UL or other third party testing agency recognized by The State of North Carolina as suitable for purpose specified and indicated.

## **PART 2 PRODUCTS**

### **2.01 EXPANSION MODULE**

- A 8 zone expander module with supervised zones and audible locator. NAPCO GEM-EZM8 or equal. Expansion module shall be by same manufacturer as the existing control panel.

### **2.02 KEYPAD**

- A Backlit 16 character LCD alphanumeric display keypad, with full sized touchtone keys that brighten when touched and built in four zone expansion module. NAPCO GEM-RPCa2 or equal. Keypad shall be by same manufacturer as the existing control panel.

### **2.03 POWER SUPPLY**

- A Power supply: Adequate to serve control panel modules and remote detectors, minimum 5 amp-hour supervised power supply/charger. Include battery-operated emergency power supply with capacity for operating system in standby mode for 24 hours.

### **2.04 INITIATING DEVICES**

- A Passive Infrared Motion Detector:
  1. Wide Angle - DSC-BRAVO 600 dual PIR
  2. Long Range - Aritech AP-633/AP643 Passive Infrared Detector

### **2.05 CONDUCTORS**

- A Data / Signaling cable - 22 awg., 2 pair UTP, West Penn #25242 (plenum rated).
- B Power cable -18 AWG 2 PR., stranded, West Penn #25225 (plenum rated).
- C Network cable: Cat-6 (plenum rated).

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A Install and program in accordance with manufacturer's instructions.
- B Use cables as described in B, 7 above, with bridle rings every 10" to properly cabling.
- C Provide and install Cat-6 plenum cabling connection to owner's network. Coordinate closely with owner's Security and IT Departments.
- D Prior to installation, final device locations and zoning shall be submitted and approved by Owner.
- E All conductors shall be concealed in ¾" C to accessible ceiling void.
- F Keypads shall be wall mounted 5' above finished floor. All circuiting routed from control panel and or instrument boxes shall be concealed in ¾"C or 1"C conduit. Conduit(s) shall be accessible to ceiling voids. No exposed conductors will be permitted at the panel or instrument boxes where field wiring" (i.e. power supplies, transformer, ezm's or any other devices terminate into an instrument box).
- G Each device shall be individually zoned.
- H No splices in conductors shall be permitted at any point in system.
- I EZM modules shall not be mounted above ceiling. Mount EZM modules 5-0" off in a surface wall box (Mier Instruments or equal, 11" x 14" x 4") in mechanical/electrical rooms or Telco closets. Locate all EZM modules and power supplies on shop drawings for approval prior to installation.
- J Support all cables above accessible ceilings with "J" hooks or saddled bridle rings fastened to structure. Cables shall not share J-hooks with other system cables.
- K No exposed conductors permitted. Install nylon bushings in all conduits extended to ceiling void.
- L Contractor is responsible for programming the system and testing functionality. (Contractor
- M Provide lightning/surge suppressors for intrusion detection system.

### **3.02 FIELD QUALITY CONTROL**

- A Field inspection and testing will be performed under provisions of Division 1.
- B Test in accordance with NFPA 72H.

### **3.03 MANUFACTURERS FIELD SERVICES**

- A Prepare and start systems under provisions of Division 1.
- B Include services of technician to supervise installation, adjustments, final connections, system testing, and Owner training.

**3.04 SYSTEM TESTING AND CERTIFICATION**

- A Upon completion of the installation of the intrusion detection system, authorized representatives shall together test each and every initiating device for proper response and annunciation. Each area shall be verified for proper office, classrooms, corridors, numbers/names and locations.
- B After successful completion of inspections and test, the warranty period begins. In the event of malfunctions or excessive false alarms, the Contractor must take prompt corrective actions. The Owner may require a repeat of the Contractor's 100% system test or other inspections. Continued improper performance during the warranty period shall be cause to require the Contractor to remove the system.

**END OF SECTION 281601 28 31 12**

**SECTION 28 46 00**  
**FIRE DETECTION AND ALARM**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A An expansion of the existing Notifier 320 Fire alarm system. This includes the design and installation, including all components, wiring, and conduit for the renovated area. In addition this existing system shall be interconnected with the new voice evacuation system in the new Gymnasium building.
- B Transmitters for communication with supervising station.
- C Replacement and removal of existing fire alarm system components, wiring, and conduit indicated.

**1.02 REFERENCE STANDARDS**

- A NFPA 70 - National Electrical Code; National Fire Protection Association, Including All Applicable Amendments and Supplements; 2020.
- B NFPA 72 - National Fire Alarm and Signaling Code; 2013
- C NFPA 101 - Life Safety Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

**1.03 SCOPE**

- A Expand the existing Notifier 320 Fire Alarm system to accommodate the renovated area in the existing building. Contractor shall provide all parts and pieces required to achieve a fully functional system.
- B If at any point the existing fire alarm system is inactive for any reason throughout the course of construction, the Contractor shall provide 24 hour fire watch. Coordinate exact fire watch requirements with the local fire marshal.

**1.04 SUBMITTALS**

- A Proposal Documents: Submit the following with cost/time proposal:
  - 1. NFPA 72 "Record of Completion", filled out to the extent known at the time.
  - 2. Manufacturer's detailed data sheet for each control unit, initiating device, and notification appliance.
  - 3. Certification by Contractor that the system design will comply with Contract Documents.
- B Drawings must be prepared using the latest release of ACAD.
- C Evidence of designer qualifications.
- D Design Documents: Submit all information required for plan review and permitting by authorities having jurisdiction, including but not limited to floor plans, riser diagrams, and description of operation:
  - 1. NFPA 72 "Record of Completion", filled out to the extent known at the time.
  - 2. Clear and concise description of operation, with input/output matrix similar to that shown in NFPA 72 Appendix A-7-5-2.2(9), and complete listing of software required.
  - 3. System zone boundaries and interfaces to fire safety systems.
  - 4. Location of all components, circuits, and raceways; mark components with identifiers used in control unit programming.
  - 5. Circuit layouts; number, size, and type of raceways and conductors; conduit fill calculations; spare capacity calculations; notification appliance circuit voltage drop calculations.
  - 6. System response matrix.
  - 7. System riser diagram
  - 8. Battery calculations showing voltage drop after required standby time.
  - 9. List of all devices on each signaling line circuit, with spare capacity indicated.
  - 10. Manufacturer's detailed data sheet for each component, including wiring diagrams, installation instructions, and circuit length limitations.
  - 11. Description of power supplies; if secondary power is by battery include calculations demonstrating adequate battery power.
  - 12. Certification by either the manufacturer of the control unit or by the manufacturer of each other component that the components are compatible with the control unit.
  - 13. Certification by the manufacturer of the control unit that the system design complies with Contract Documents.
  - 14. Certification by Contractor that the system design complies with Contract Documents.
  - 15. Do not show existing components to be removed.

- E Evidence of installer qualifications.
- F Inspection and Test Reports:
  - 1. Submit inspection and test plan prior to closeout demonstration.
  - 2. Submit documentation of satisfactory inspections and tests.
  - 3. Submit NFPA 72 "Inspection and Test Form," filled out.
- G Operating and Maintenance Data: have one set available during closeout demonstration:
  - 1. Original copy of NFPA 72 with portions that are not relevant to this project neatly crossed out by hand; label with project name and date.
  - 2. Complete set of specified design documents, as approved by authority having jurisdiction.
  - 3. Additional printed set of project record documents and closeout documents, bound or filed in same manuals.
  - 4. List of recommended spare parts, tools, and instruments for testing.
  - 5. Replacement parts list with current prices, and source of supply.
  - 6. Detailed troubleshooting guide and large scale input/output matrix.
  - 7. Preventive maintenance, inspection, and testing schedule complying with NFPA 72; provide printed copy and computer format acceptable to Owner.
  - 8. Detailed but easy to read explanation of procedures to be taken by non-technical administrative personnel in the event of system trouble, when routine testing is being conducted, for fire drills, and when entering into contracts for remodeling.
- H Project Record Documents: Have one set available during closeout demonstration:
  - 1. Complete set of floor plans showing actual installed locations of components, conduit, and zones.
  - 2. "As installed" wiring and schematic diagrams, with final terminal identifications.
  - 3. "As programmed" operating sequences, including control events by device, updated input/output chart, and voice messages by event.
  - 4. Graphic Chart mounted behind plexiglass and secured to wall at FACP and remote annunciator(s). Graphic chart shall indicate all fire alarm devices including the programmed addresses for each device. Frame shall not be removable with standard philips or flat head screw drivers.
  - 5. A copy of the floor plans with device numbers shall be provided in the control panel. Provide a separate sheet for each floor scaled to be on 11 x17 sheets. All devices shall be clearly labeled and a legend provided on the drawings. Indicate locations of cabinets, modules, and end of line devices. Plans shall be bound and sheets laminated. Provide plan holder in panel or in locked box adjacent to panel keyed to match panel.
  - 6. Provide CD copy of complete configuration data (site specific programming) for the system submitted to the engineer for distribution to the owner.
  - 7. Contractor shall provide the following to the owner
    - a. All software required, both for the installed fire alarm system and personal computer necessary to access the fire alarm system for trouble shooting, programming, modifications, monitoring, debugging, or similar functions.
    - b. Complete documentation for all software for both the installed fire alarm system and for any interface PC software necessary for the functions described above.
    - c. Interconnection cable where such is required to connect the fire alarm system to a PC.
- I Closeout Documents:
  - 1. Certification by manufacturer that the system has been installed in compliance with manufacturer's installation requirements, is complete, and is in satisfactory operating condition.
  - 2. NFPA 72 "Record of Completion", filled out completely and signed by installer and authorized representative of authority having jurisdiction.
  - 3. Certificate of Occupancy.
  - 4. System Report: Provide Engineer two bound copies of the following for transfer to the owner.
    - a. As-built wiring diagram showing all loop numbers and device addresses, plus terminal numbers and where they connect to control equipment.
    - b. As-built wiring and conduit layout diagrams, including wire color code and/or label numbers, and showing interconnections in the system.

- c. Electronic circuit diagrams of all control panels, modules, annunciators, communications panels, etc.
  - d. Manufacturer's detailed maintenance requirements.
  - e. Product data on all devices.
  - f. As-built calculation sheets showing system capacity and voltage drops.
- J Maintenance Materials, Tools, and Software: Furnish the following for Owner's use in maintenance of project.
1. Furnish spare parts of same manufacturer and model as those installed; deliver in original packaging, labeled in same manner as in operating and maintenance data.
  2. In addition to the items in quantities indicated in PART 2, furnish the following:
    - a. All tools, software, and documentation necessary to modify the fire alarm system using Owner's personnel; minimum modification capability to include addition and deletion of devices, circuits, and zones, and changes to system description, operation, and evacuation and instructional messages.
    - b. One copy, on CD-ROM, of all software not resident in read-only-memory.
    - c. Extra Fuses: Two for each installed fuse; store inside applicable control cabinet.

### 1.05 QUALITY ASSURANCE

- A Designer Qualifications: NICET Level III or IV (3 or 4) certified fire alarm technician or registered fire protection engineer, employed by fire alarm control panel manufacturer, Contractor, or installer, with experience designing fire alarm systems in the jurisdictional area of the authorities having jurisdiction.
- B Installer Qualifications: Firm with minimum 5 years documented experience installing fire alarm systems of the specified type and providing contract maintenance service as a regular part of their business.
1. Authorized representative of control unit manufacturer; submit manufacturer's certification that installer is authorized; include name and title of manufacturer's representative making certification.
  2. Installer Personnel: At least 2 years of experience installing fire alarm systems.
  3. Supervisor: NICET level III or IV (3 or 4) certified fire alarm technician; furnish name and address.
  4. Technician must be trained and individually certified by the manufacturer, for the Master Control Unit installed. Training must have occurred within the most recent 24 month. If NICET level III certification shall extend to 36 months.
  5. Contract maintenance office located within 50 miles of project site.
  6. Certified in the State in which the Project is located as fire alarm installer.
  7. Only the installer may make programming changes and must be present at the 100% test, Designer's pre-final review and Owner's final inspection.
- C Product Listing Organization Qualifications: Third party agencies shall be amongst those accredited by the NCBC (North Carolina Building Code Council) to label Electrical and Mechanical Equipment.

### 1.06 WARRANTY

- A Provide the necessary expansion cards, etc. to the existing panel to accommodate the renovation. Provide a manufacturer's warranty that system components other than wire and conduit are free from defects and will remain so for 1 year after Owner's acceptance.
- B Provide installer's warranty that the installation is free from defects and will remain so for 1 year after date of Owner's acceptance.
- C Warranty shall cover all parts and labor required to correct any deficient parts.

## PART 2 PRODUCTS

### 2.01 MANUFACTURERS

- A Addressable analog fire alarm system:
1. Notifier. (Existing to be expanded)

### 2.02 FIRE ALARM SYSTEM

- A Fire Alarm System: Expand the Existing Notifier 320 Addressable Fire Alarm system
1. Provide all components necessary, regardless of whether shown in Contract Documents or not.
  2. Protected Premises: (Entire Building).
  3. Comply with the following; where requirements conflict, order of precedence of requirements is as listed:

- a. ADA Standards.
  - b. The requirements of the State Fire Marshal.
  - c. The requirements of the local authority having jurisdiction.
  - d. Applicable local codes.
  - e. Contract Documents (drawings and specifications).
  - f. NFPA 72; where the word "should" is used consider that provision mandatory; where conflicts between requirements require deviation from NFPA 72, identify deviations clearly on design documents.
4. Evacuation Alarm: Multiple smoke zones; allow for evacuation notification of any individual zone or combination of zones, in addition to general evacuation of entire premises.
  5. General Evacuation Zones: Each smoke zone is considered a general evacuation zone unless otherwise indicated, with alarm notification in all zones on the same floor, on the floor above, and the floor below.
  6. Hearing Impaired Occupants: Provide visible notification devices in all public areas.
- B Supervising Stations and Fire Department Connections: (Maintain the existing transmission method)
1. Public Fire Department Notification: By on-premises supervising station.
  2. Remote Supervising Station: UL-listed central station under contract to facility.
  3. Means of Transmission to Remote Supervising Station: Multi-technology digital alarm communicator transmitter (DACT). DACT shall utilize one traditional phone line and be capable of IP phone and cellular communications to comply with the 2013 NFPA 72 requirements for multiple communication methods.
    - a. The following signals shall be reported as applicable
      - 1) Fire Alarm
      - 2) Fire Alarm System AC Power Trouble (loss of power for 1 hour or more).
    - b. Signal precedence to the supervising station shall be per NFPA 72 and as defined below.
      - 1) Fire Alarm
      - 2) Supervisory Signal
      - 3) Trouble Signal
    - c. The DACT is existing and will remain it is compatible with the supervising station. Contractor shall verify proper signal receipt with supervising station and ensure compliance with NFPA 72.
- C Circuits:
1. Initiating Device Circuits (IDC): Class A.
  2. Signaling Line Circuits (SLC): Class A with no T taps.
  3. Notification Appliance Circuits (NAC): Class B.

### 2.03 EXISTING COMPONENTS

- A Existing Fire Alarm System: Remove existing components indicated and incorporate remaining components into new system, under warranty as if they were new; do not take existing portions of system out of service until new portions are fully operational, tested, and connected to existing system.
- B Clearly label components that are "Not In Service."
- C Remove unused existing components and materials from site and dispose of properly.

### 2.04 FIRE SAFETY SYSTEMS INTERFACES

- A Supervision: Provide supervisory signals in accordance with NFPA 72 for the following:
1. Sprinkler water control valves.
  2. Elevator shut-down control circuits.
- B Alarm: Provide alarm initiation in accordance with NFPA 72 for the following:
1. Sprinkler water flow.
  2. Kitchen hood suppression activation; also disconnect fuel source from cooking equipment.
  3. Elevator lobby, elevator hoistway, and elevator machine room smoke detectors.
  4. Duct smoke detectors.
- C Elevators:
1. Elevator lobby, hoistway, and machine room smoke detectors: Elevator recall for fire fighters' service.



2. Elevator Machine Room Heat Detector: Shut down elevator power prior to hoistway sprinkler activation.
  3. Sprinkler pressure or waterflow: Shut down elevator power prior to hoistway sprinkler activation.
- D HVAC:
1. Duct Smoke Detectors: Close dampers indicated; shut down air handlers indicated.
- E Doors:
1. Smoke Barrier Door Magnetic Holders: Release upon activation of smoke detectors in smoke zone on either side of door, upon alarm from manual pull station on same floor, and upon sprinkler activation on same floor. Refer to Section 08 71 00. Door hold open magnets may release 60 seconds after loss of 120V power.
- F Kitchen exhaust hood extinguishing systems
1. Installation shall comply with the current accepted edition of NFPA 72 for the type of system installed.
  2. System shall be interconnected with fire alarm system as a separate system address.

## 2.05 COMPONENTS

- A General:
1. Provide flush mounted units where installed in finish areas; in unfinished areas, surface mounted unit are acceptable.
  2. Provide legible, permanent labels for each control device, using identification used in operation and maintenance data.
  3. Consult with facility manager and local fire official prior to locating Master Control Unit, remote annunciator, or system printer.
  4. System Capacity and General Operation: The system shall have the following capacities and general operation modes:
    - a. The FACP shall provide, or be capable of expansion to 198 intelligent/addressable devices per Signaling Line Circuits (SLC) and 2000 annunciation points, minimum, per system. The number of SLCs provided shall be as indicated on the Drawings. Total points shall be as indicated on the drawings or otherwise specified.
    - b. The FACP shall include a full featured operator interface control and annunciation panel that shall include a backlit, 80 minimum character liquid crystal display, individual, color coded system status LEDs, and an alphanumeric keypad for the field programming and control of the fire alarm system.
    - c. All programming or editing of the existing program in the system shall be achieved without special equipment and without interrupting the alarm monitoring functions of the fire alarm control panel.
- B Fire Alarm Control Units: Analog, addressable type; listed, classified, and labeled as suitable for the purpose intended.
- C System Response Conditions.
1. Alarm Condition - When a fire alarm condition is detected and reported by one of the system initiating devices, the following functions shall immediately occur:
    - a. The system alarm LED shall flash.
    - b. A local piezo-electric signal in the control panel shall sound.
    - c. LCD display shall indicate all information associated with the fire alarm condition, including the type of alarm point and its location.
    - d. On systems equipped with a printer, printing and history storage shall log the information associated with each new fire alarm signal, along with the time and date of occurrence.
    - e. All system outputs assigned via control-by-event equations to be activated by a particular point shall be executed.
    - f. Activate all fire alarm Notification Appliances.
    - g. Activate digital alarm communicator.
    - h. Deactivate all door hold control relays.
    - i. Activate control relays to initiate AHU shutdown.

- j. In buildings with elevators, activate elevator recall sequence when elevator initiating device is activated.
  2. Trouble or Supervisory Condition - When a trouble condition is detected the following stipulations apply:
    - a. System AC power trouble shall not be sent unless maintained for 3 hours or more. Provide additional relays as required for this purpose.
    - b. Provide adjustable time delay for all other trouble signals prior to transmission.
    - c. Supervise all initiating, signaling, and notification circuits throughout the facility by way of monitor and control modules.
    - d. Visually and audibly annunciate any trouble, supervisory condition on operator's terminals, panel display, and annunciators.
- D Display: The system display shall provide all the controls and indicators used by the system operator and may also be used to program all system operational parameters. The display assembly shall contain, and display as required, custom alphanumeric labels for all intelligent detectors, addressable modules, and software zones.
  1. The system display shall provide an 80 minimum-character back-lit alphanumeric Liquid Crystal Display (LCD).
  2. The Display shall also provide four Light-Emitting-Diodes (LEDS), that will indicate the status of the following system parameters: AC POWER, SYSTEM ALARM, SYSTEM TROUBLE, and SIGNAL SILENCE.
  3. The system display shall provide a touch key-pad with control capability to command all system functions, entry of any alphabetic or numeric information, and field programming. Two different password levels shall be accessible through the display interface assembly to prevent unauthorized system control or programming.
- E Initiating Devices:
  1. Addressable Systems:
    - a. Addressable Devices: Individually identifiable by addressable fire alarm control unit.
    - b. Provide suitable addressable interface modules as indicated or as required for connection to conventional (non-addressable) devices and other components that provide a dry closure output.
  2. Addressable Devices - General: All initiating devices shall be individually addressable. Addressable devices shall comply with the following requirements:
    - a. All addressable spot type and duct smoke detectors shall be the analog type and the alarm system shall automatically compensate for detector sensitivity changes due to ambient conditions and dust build-up within detectors. This feature must be armed and sensitivities set prior to acceptance of the system.
    - b. Address Setting: Addressable devices shall provide an address-setting means.
    - c. Connections: Addressable devices shall be connected to a Signaling Line Circuit (SLC) with two (2) wires.
    - d. Operational Indications: Addressable initiation devices shall provide dual alarm and power LEDs. Both LEDs shall flash under normal conditions, indicating that the device is operational and in regular communication with the control panel. Both LEDs shall be placed into steady illumination by the FACP to indicate that an alarm condition has been detected. The flashing mode operation of the detector LEDs shall be optional through the system field program. An output connection shall also be provided in the device base to connect an external remote alarm LED.
    - e. Intelligent Initiation Devices: All smoke detectors shall be the "intelligent" in that smoke detector sensitivity shall be set through the FACP and shall be adjustable in the field through the field programming of the system. Sensitivity shall be capable of being automatically adjusted by the FACP on a time-of-day basis. Using software in the FACP, detectors shall be capable of automatically compensating for dust accumulation and other slow environmental changes that may affect performance. The detectors shall be listed by UL as meeting the calibrated sensitivity test requirements of NFPA Standard 72.

- f. Spot-type detectors must be the plug-in type, with a separate base (not a mounting ring), to facilitate their replacement and maintenance. The base shall have integral terminal strips for circuit connections, rather than wire pigtails. Each detector or detector base shall incorporate an LED to indicate alarm.
  3. Smoke Detectors General Requirements:
    - a. Spot-type detectors must be the plug-in type, with a separate base (not a mounting ring), to facilitate their replacement and maintenance. The base shall have integral terminal strips for circuit connections, rather than wire pigtails. Each detector or detector base shall incorporate an LED to indicate alarm.
    - b. Device mounting Base: Unless otherwise specified all detectors shall be ceiling-mount and shall include a separate twist-lock base with locking tamper proof feature.
    - c. Sounder Base: Where indicated on plans provide bases with a built-in (local) sounder rated at 85 dBA minimum, measured at 10 ft. Configure sounder bases such that sounders are activated under conditions as described in the Matrix.
    - d. Test Means: The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself (by activating a magnetic switch) or initiated remotely on command from the control panel when in the "test" condition.
    - e. Device Identification: Detectors shall store an internal identifying type code that the control panel shall use to identify the type of device. Device identifications shall be either ION, PHOTO, or THERMAL.
    - f. Photoelectric Smoke Detectors: Photoelectric smoke detectors shall use the photoelectric (light-scattering) principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density.
    - g. Ionization Smoke Detector: Ionization smoke detectors shall use the dual-chamber ionization principal to measure products of combustion and shall, on command from the control panel, send data to the panel representing the analog level of products of combustion.
  4. Thermal Detectors: Thermal Detectors shall be intelligent addressable devices rated at 135°F (58°C) and shall have a rate-of-rise element rated at 15° F. (9.4°C) per minute. It shall connect via two wires to the Fire Alarm Control Panel Signaling Line Circuit. Up to 99 intelligent heat detectors may connect to one SLC loop. Thermal detectors shall use an electronic sensor to measure thermal conditions caused by a fire and shall, on command from the control panel, send data to the panel representing the analog level of such thermal measurements.
  5. Duct Smoke Detector: In-Duct Smoke Detector Housings shall accommodate a velocity rated photoelectric detector. The device, independent of the type used, shall provide continuous analog monitoring and alarm verification from the panel. When sufficient smoke is sensed, an alarm signal shall be initiated at the FACP. Proper installation and physical location of each duct detector and access door shall be coordinated between the electrical, the mechanical and the fire alarm sub-contractors and approved by the electrical and mechanical engineers prior to equipment installation.
    - a. Each Duct detector shall have a hinged duct access panel, 12 x 12 inches minimum for sampling tube inspection and cleaning. Indicate airflow direction on the duct adjacent to detector using permanent decal.
    - b. Duct detector sampling tubes shall extend the full width of the duct. Sampling tubes over 36 inches long must be provided with far end support for stability. Install sampling tube per manufacturer's instructions.
    - c. All duct detectors shall be programmed for alarm.
  6. Remote annunciator Indicator Lights (RAIL): RAILS shall be provided for initiating devices where indicated on the plans. RAILS shall be provided with a key type switch for testing of the annunciated device. All RAILS shall be 24 VDC.
  7. Addressable Pull Stations - General: Addressable pull stations shall, on command from the Control Panel, send data to the panel representing the state of the manual switch. They shall use a key operated test-reset lock, and shall be designed so that after actual emergency operation, they cannot be restored

- to normal use except by the use of a key. All pull stations shall be dual-action, have a positive, visual indication of operation and utilize a key type reset. The Glass-break rods are not allowed.
- F Notification Appliances:
1. Programmable Electronic Sounders (Horns): Sounders located outdoors or in damp or wet locations shall be listed for use in wet locations. Electric sounders shall operate with synchronized audible output and have the following specifications: .
    - a. Voltage: Programmable electronic sounders shall operate on 24 VDC nominal.
    - b. Programming: Electronic Sounders shall provide the ANSI 53.41 three-pulse temporal pattern audible evacuation signal, described in NFPA 72, with an output sound level of at least 90 dBA measured at 10 feet from the device. Output sound level shall be 120 dB maximum. Electronic Sounders shall be field programmable without the use of special tools.
  2. Strobes: shall be located as shown on the Drawings and provided per the requirements of the NCSBC chapter #11 and ICC A117.1-2009. Strobe lights indicated for use exterior to the building shall be mounted at the indicated elevation and listed for use in wet locations. Strobe lights shall operate with synchronized flash output and have the following specifications:
    - a. Voltage: Strobe lights shall operate on 24 VDC nominal.
    - b. Maximum pulse duration: 2/10ths of one second.
    - c. Strobe intensity and flash rate: Must meet minimum requirements of UL 1971. Provide strobe lights with minimum intensity Candela (Cd) rating of 15/75 Cd, or greater if shown otherwise on drawings.
  3. Audible/Visual Combination Devices shall comply with all applicable requirements for both Programmable Electronic Sounders and Strobe Lights.
- G Miscellaneous System Items
1. Addressable Dry Contact Monitor Module: Addressable Monitor Modules shall be provided to connect one supervised zone of non-addressable Alarm Initiating Devices (any Normally Open [N.O.] dry contact device) to one of the Fire Alarm Control Panel Signaling Line Circuit Loops. Monitor modules shall be installed as required by the system configuration. All required monitor modules may not be shown on the Drawings.
    - a. Indication of Operation: An LED shall be provided that shall flash under normal conditions, indicating that the Monitor Module is operational and in regular communication with the control panel.
    - b. Supervision: Unless specifically noted otherwise on the drawings provide one monitor module for each sprinkler switch.
  2. Two Wire Detector Monitor Module: Addressable Monitor Modules shall be provided to connect one supervised IDC zone, Class A or alarm initiating devices (any N.O. dry contact device) to one of the Fire Alarm Control Panel Signaling Line Circuit Loops. Monitor modules shall be installed as required by the system configuration. All required monitor modules may not be shown on the Drawings. Indication of Operation: Unless otherwise indicated on the Drawings an LED shall be provided that shall flash under normal conditions, indicating that the Monitor Module is operational and in regular communication with the control panel.
  3. Addressable Control Module: Addressable Control Modules shall be provided to supervise and control the operation of one conventional Notification Appliance Circuit (NAC) of compatible, 24 VDC powered, polarized Audio/Visual (A/V) Notification Appliances. For fan shutdown and other auxiliary control functions, the control module may be set to operate as a dry contract relay. The control module shall provide address-setting means using DIP switches and shall also store an internal identifying code that the control panel shall use to identify the type of device. An LED shall be provided that shall flash under normal conditions, indicating that the control module is operational and is in regular communication with the control panel.
    - a. Configuration: The control module NAC circuit may be wired for Class B with up to 1 Amp of inductive A/V signal, or 2 Amps of resistive A/V signal operation, or as a dry contact (Form C) relay. The control module shall be suitable for pilot duty applications and rated for a minimum of 0.6 amps at 30 VDC. The relay coil shall be magnetically latched to reduce wiring connection

- requirements, and to insure that 100% of all auxiliary relay or NACs may be energized at the same time on the same pair of wires.
- b. Power Source: Audio/visual power shall be provided by a separate supervised power loop from the main fire alarm control panel or from a supervised, 3rd party listed remote power supply. AN power sources and connections are not shown on the Drawings
  - c. Test Switch: A magnetic test switch shall be provided to test the module without opening or shorting its NAC wiring.
4. Isolator Module: Isolator Modules shall be provided to automatically isolate wire-to-wire short circuits on an SLC loop. The Isolator Module shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the SLC Loop. Modules must be readily accessible (not above ceiling) and clearly labeled.
- a. Operation: Isolator Modules shall operate such that if a wire-to-wire short occurs, the Isolator module shall automatically open-circuit (disconnect) the SLC loop. When the short circuit condition is corrected, the Isolator Module shall automatically reconnect the isolated section. The Isolator Module shall not require any address-setting, and its operations shall be totally automatic. It shall not be necessary to replace or reset an Isolator Module after its normal operation.
  - b. The Isolator Modules shall provide a single LED that shall flash to indicate that the Isolator is operational and shall illuminate steadily to indicate that a short circuit condition has been detected and isolated.
  - c. Isolation modules must be provided in the following locations as a minimum.
    - 1) Immediately adjacent to the Main Fire Alarm Control Unit, at each end of the addressable loop. These two isolators must be within 15 feet of the Main Fire Alarm Control Unit.
    - 2) After each 20 initiating devices and control points on the addressable loop.
    - 3) For loops with 20 or less control points install isolation module in approximately the middle of the loop.
    - 4) Near the point where any addressable loop extends outside the building envelope.
    - 5) For loops covering more than one floor where addressable loop crosses between floors.
  - d. Each isolation module must be clearly labeled, readily accessible for convenient inspection.
5. Water Flow Switch: Flow switches shall be integral, mechanical, non-coded, non-accumulative retard type. Flow switches shall have an alarm transmission delay time that is conveniently adjustable from 0 to 60 seconds. Initial settings shall be 30-45 seconds. Flow switches shall be located a minimum of one (1) foot from a fitting that changes the direction of the flow and a minimum of three (3) feet from a valve as required per NFPA 13. Installation: Water Flow Switches shall be connected by the Division 26 (Electrical) Contractor but furnished and installed by the Division 23 (Mechanical) Contractor.
6. Sprinkler and Standpipe Valve Supervisory Switch: Supervisory switch mechanisms shall be contained in a weatherproof housing that shall provide a 3/4 inch tapped conduit entrance and shall incorporate the necessary facilities for attachment to the valves. Switch housing shall be finished in red baked enamel. Mounting: Mount switch so as not to interfere with the normal operation of the valve and adjust to operate within two revolutions toward the closed position of the valve control, or when the stem has moved no more than one-fifth of the distance from its normal position.
7. Remote Annunciator Indicator Lights (RAIL): RAILS shall be provided with a key type switch for testing of the annunciated device. In addition, RAILS shall have the following features: Voltage: RAILS shall operate on 24 VDC nominal.
8. Door Hold-Open magnets:
- a. Door hold open magnets shall be suitable for mounting in a single gang electrical device box.
  - b. Door hold open magnets shall be furnished with keepers, door chains, and other accessories as required to properly hold open doors as indicated on the Drawings.
  - c. Wall mounted magnetic door holders and separate heavy duty closers shall be used instead of combination door control units.
  - d. Holding force of the magnet shall be appropriate for the door to be held open. Door hold open magnets shall operate in a fail safe manner, i.e., the door shall release in event of a failure of voltage to the device.

- e. Power Source: Door hold open magnets shall be configured to operate from a nominal 24 VDC system as supplied by the FACP or other power supply listed for the purpose.
  - f. All hold open magnet supply sources, whether a part of the FACP or whether derived from a separate power supply, shall be supervised.
  - g. Door hold open magnet circuits which use step-down transformers, 120 VAC, or local relays are not permitted.
  - h. Door shall close after 60 seconds of the power loss.
9. Battery Power Supply (BPS) &/or Supplementary Notification Appliance Circuit (SNAC): These types of panels shall be completely maintenance free, shall not require liquids, fluid level checks or refilling, and shall not be capable of producing spills and/or leaks. Batteries shall be sealed gel-cell type with expected life of 10 years. Battery voltage shall be as required by the FACP and related equipment. Battery shall have sufficient capacity to power the fire alarm system for not less than 60 hours plus 15 minutes of alarm upon a normal AC power failure. Battery cabinet shall be twice the size of the batteries it will contain. NAC circuits shall not exceed 75% of maximum current load allowed.
- a. The voltage drop at EOL must not exceed 14% of the expected battery voltage after the required standby and alarm times. Determine worst case voltage at far end of each NAC circuit. The results must not be than the minimum listed rating on the device.
  - b. Where voltage drop or capacity limits are exceeded provide additional NAC panels as required for a fully functional system.
  - c. All power supplies shall be capable of withstanding prolonged short circuits in the field wiring, either line-to-line or line-to-ground, without damage.
  - d. All power supplies shall be equipped with battery charging using dual-rate charging techniques for fast battery recharge.
10. Enclosure: All equipment enclosures shall be third party listed suitable for surface or semi-flush mounting. Cabinet and front shall be corrosion resistant, given a rust-resistant prime coat, and manufacturer's standard finish. The door shall provide a key lock and a glass opening for viewing indicators. Door hinge shall be field selectable (left or right).
- H Wiring
1. Addressable loop (signaling line) circuits shall be wired with type FPL/FPLR/FPLP fire alarm cable, AWG 18 minimum, low capacitance, twisted shielded copper pair. Cable shield drain wires are to be connected at each device on the loop to maintain continuity, taped to insulate from ground, and terminated at the FACP. Acceptable cables include Atlas 228-18-1-1STP, BSCC S1802s19 (same as EEC 7806LC), West Penn D975, D991 (AWG 16), D995 (AWG 14), or equal wire having capacitance of 30pf/ft. maximum between conductors. Belden 5320FJ acceptable if only FPL rating needed.
    - a. Unshielded cable, otherwise equal to the above, is permitted to be used if the manufacturer's installation manual requires, or states preference for, unshielded cable.
    - b. In underground conduit, use Type TC or PLTC cable (PE insulated) to avoid problems from moisture.
    - c. The following conductor color coding shall be maintained throughout the system:
      - 1) Initiating Circuits: Red (+)/White (-)
      - 2) Initiating Circuits, Smoke Only: Violet (+)/Grey (-)
      - 3) Signal Line Circuits: Red jacket with Red (+)/Black(-)
      - 4) Alarm Indicating Appliance Circuits: Blue (+)/Black(-)
      - 5) AHU Shutdown Circuits: Yellow (+)/Brown (-)
      - 6) Door Control Circuits: Orange
      - 7) Elevator Capture Circuits: Brown
  2. Supervision must be provided between individual addressable modules and their associated contact type initiating devices.
- I Surge Protection: In accordance with IEEE C62.41.2 category B combination waveform and NFPA 70; except for optical fiber conductors.
1. For each AC power circuit that interfaces with fire alarm equipment install an AC suppressor in a listed enclosure near the electrical panelboard, and trim excess lead lengths. Wind small coil in the branch

- circuit conductor just downstream of the suppressor connection. Coil to be 5 to 10 turns, about 1" diameter, and securely tie-wrapped. This series impedance will improve the effectiveness of the suppressor in clipping fast rise time voltage transients.
2. Equipment Connected to Alternating Current Circuits: Maximum let through voltage of 350 V(ac), line-to-neutral, and 350 V(ac), line-to-line; do not use fuses.
  3. Initiating Device Circuits, Notification Appliance Circuits, and Communications Circuits: Provide surge protection at each point where circuit exits or enters a building; rated to protect applicable equipment; for 24 V(dc) maximum dc clamping voltage of 36 V(dc), line-to-ground, and 72 V(dc), line-to-line.
  4. On DC circuits extending outside the building: Provide surge protection at each point where circuit exits or enters a building, rated to protect applicable equipment.
- J Locks and Keys: Deliver keys to Owner.
1. Provide the same standard lock and key for each key operated switch and lockable panel and cabinet; provide 5 keys of each type
- K Instruction Charts: Printed instruction chart for operators, showing steps to be taken when a signal is received (normal, alarm, supervisory, and trouble); easily readable from normal operator's station.
1. Frame: Stainless steel or aluminum with polycarbonate or glass cover.
  2. Provide one for each control unit where operations are to be performed.
  3. Obtain approval of Owner prior to mounting; mount in location acceptable to Owner.
  4. Provide extra copy with operation and maintenance data submittal.
- L SPARE PARTS:
1. The following spare parts shall be provided with the system. For multi-building projects, calculate quantities separately for each building that contains a dedicated fire alarm control panel. If FACP also serves auxiliary buildings (e.g., storage, boiler/chiller), calculate as if one building. Increase decimal quantities to the next higher whole number.
    - a. • Fuses (If Used) 2 of each size in system
    - b. Manual Fire Alarm Boxes 2% of installed quantity
    - c. Addressable Control Relays 4% of installed quantity
    - d. • Indoor Horns/Speakers with Strobes Lights 4% of installed quantity
    - e. Indoor Strobe-only Notification Appliances 4% of installed quantity
    - f. Monitor Modules (Addressable Interface) 4% of installed quantity
    - g. Isolation Modules I Isolation Bases 4% of installed quantity
    - h. Addressable, Electronic Heat Detectors 4% of installed quantity
    - i. • Spot-Type Smoke Detectors I Sounder Bases 6% of installed quantity
    - j. \* No spares are required for projected beam, air sampling, or duct smoke detectors

### PART 3 EXECUTION

#### 3.01 INSTALLATION

- A Install in accordance with applicable codes, NFPA 72, NFPA 70, and Contract Documents.
- B Conceal all wiring, conduit, boxes, and supports where installed in finished areas.
- C All equipment supplied must be specifically listed for its intended use and shall be installed in accordance with the manufactures recommendations. The contractor shall consult the manufacturer's installation manuals for all wiring diagrams, schematics, physical equipment sizes, etc., before beginning system installation. Contractor shall refer to the Riser/Connection diagram for all specific system installation/termination/wiring data.
- D All system components shall be attached to walls and ceiling/floor assemblies and shall be held firmly in place (e.g., detectors shall not be supported solely by suspended ceilings). Fasteners and supports shall be adequate to support the required load. Adhesives are not permitted to mount fire alarm system components to building surfaces or structure.
- E The system shall be electrically supervised for open or ground fault conditions in SLC, alarm and control circuits. Removal of any detection device, alarm appliance, plug-in relay, system module, or standby battery connection shall also result in a trouble signal.

- F When programming the system, activate the automatic drift compensation feature for all spot- type smoke detectors. Systems with alarm verification are not to have this feature activated without written direction from the owner’s representative or the AHJ. Alarm verification must not be used with multi-sensor/multi-criteria detectors under any circumstances, as inadequate system response may result. Most applications of analog addressable smoke detectors do not require alarm verification to reduce nuisance alarms, as they are better able to discriminate between fire and common non-fire ambient events. A short operational test with normal occupancy can determine if transient ambient events are a problem
- G Provide photoelectric smoke detector within 15 feet of every NAC Panel or other fire alarm control equipment. These detectors shall be provided weather shown on plans or not.
- H Set spot-type smoke detector sensitivities to normal/medium, unless directed otherwise by the design engineer/owner’s rep. High sensitivity may be appropriate in relatively benign, clean environments such as art museums and libraries, to improve system response time without causing nuisance alarms.
- I Unless suitably protected against dust and other debris, spot type smoke detectors shall not be installed until final construction clean-up has been completed. In the even that detectors are damaged during construction due to failure to adequately protect devices, they shall be replaced by the contractor at no expense to the owner.
- J Print a complete System Status and Programming Report after the above steps have been done. This must include the program settings for each alarm initiating device and the current sensitivity of each analog addressable smoke detector.
- K Install instruction cards and labels.
- L Provide engraved label at the Main Control Unit and secondary power supplies identifying the 120V power source including panelboard location, panelboard identifier, and branch circuit number.
- M Identification of individual initiating devices is required. Assign each initiating device a unique number as follows, sequence starting from the FACP: (Addressable Loop # -- Device #). Show device numbers on as built plans and permanently mark each detector base so that it is readable on the floor below without having to remove detector. Labels must be typewritten with black lettering and clear background.

### **3.02 CONDUIT AND WIRING**

- A All fire alarm system wiring shall be in metal conduit, minimum 3/4", or surface metal raceway. All fire alarm system raceway, couplers, and connectors must meet performance and installation requirements as identified in other sections of this specification manual.
- B Detection or alarm circuits must not be included in raceways containing AC power or AC control wiring. Within the Fire Alarm Control Panels, and 120V control wiring or other circuits must with an externally supplied voltage above 24 V must be properly separated from other circuits and have the appropriate warning label to alert service personnel to the potential hazard.
- C There shall be no splices in the system other than at device terminal blocks, or on terminal blocks in cabinets.
- D Permanent wire markers shall be used to identify all connections in the Main Fire Alarm Control Unit and other control equipment, at power supplies and terminal cabinets.
- E In multistory buildings, all circuits leaving the riser on each floor shall feed through a labeled terminal block in a hinged enclosure accessible from the floor.
- F All wiring terminal block screws shall have pressure wire connectors of the self-lifting or box lug type.
- G All wiring shall be checked for grounds, opens, and shorts, prior to termination at panels and installation of detector heads. The minimum allowed resistance to ground between any two conductors shall be 10 megohms, as verified with an insulation resistance test. Provide Engineer with the results of these tests.
- H The exterior of all junction boxes, including both sides of covers, containing fire alarm conductors shall be painted red. Box interior shall not be painted.
- I Box covers shall be labeled to indicate the circuit(s) or function of the conductors contained within. Labels shall be neatly applied black lettering on clear background. Handwritten labels or embossed tape labels are not allowed.
- J All conduits penetrating exterior walls must have internal sealing to prevent condensation from infiltrating humid air.



### 3.03 INSPECTION AND TESTING FOR COMPLETION

- A Notify Owner 7 days prior to beginning completion inspections and tests.
- B Notify State Construction Electrical Inspector at least 7 days in advance for observation by their personnel prior to final acceptance.
- C Provide the services of the installer's supervisor or person with equivalent qualifications to supervise inspection and testing, correction, and adjustments.
- D Prepare for testing by ensuring that all work is complete and correct; perform preliminary tests as required.
- E Provide all tools, software, and supplies required to accomplish inspection and testing.
- F Upon completion of the installation the Contractor and the Manufacturer's authorized installer together shall conduct a performance test of each and every alarm initiating device for proper response. The system shall operate for 48 hours prior to start of test. The Contractor shall be present for the full test.
- G The A/E and owner must be given 7 days advance notice of the tests. All Audio Visual Device Testing shall be scheduled with the owner.
- H 100% Test: The manufacturer or authorized distributor (by definition, "installer") must 100% test all site-specific software functions for the system and then provide a detailed report or check list showing the system's operational matrix. This documentation must be part of the "System Status and Programming Report".
  - 1. Upon completion of the installation and its programming, the installer's technician shall test every alarm initiating device for proper response and indication, and all alarm notification appliances for effectiveness. Also, in coordination with the other building system contractors, all other system functions shall be verified, including (where applicable) elevator capture and the control of HVAC systems, door locks, pressurization fans, fire or smoke doors/dampers/shutters, etc. The engineer must be notified in advance of these 100% tests, to permit witnessing them if desired.
  - 2. If AHU shutdown occurs for any alarm, then the matrix would indicate the specific control relay(s) for that function being commanded to operate for alarm from any initiating device. If a rolling steel fire door is to drop only upon waterflow alarm from its sprinkler zone, or upon any two spot smoke detectors in adjacent spaces being simultaneously in alarm, the matrix would show the door's control relay activating upon alarm from the applicable waterflow switch(es), or from any two smoke detectors in the selected spaces (AND gate).
  - 3. The digital communicator shall be on-line and tested for proper communication to the receiving station.
  - 4. All supervised circuits must also be tested to verify proper supervision. (Control circuits and remote annunciation lines are among those required to be supervised.)
  - 5. All testing described above shall be repeated in the event that subsequent software or wiring modifications are determined necessary to meet the requirements of the contract documents. Such re-testing shall be included as part of the base bid and provided at no additional cost to the Owner.
- I Test Documentation: The installer must fill out and submit the following documentation to the owner, through the engineer, prior to the AHJ's system acceptance inspection:
  - 1. Written verification that this 100% system test was done with copy of print out generated during test.
  - 2. The NFPA 72, "Record of Completion" Form. Use this form (no substitutes) to detail the system installation and also to certify that: (a.) It was done per Code, and (b.) The Code- required 100% test was performed. The fire alarm installer (manufacturer or authorized distributor's technician) must sign this form. If a representative of the AHJ, owner, or engineer witnesses the tests, in whole or in part, they must also sign the form to signify that fact only (annotating the form as needed to clarify their limited role).
  - 3. For buildings with a smoke control or smoke purge system, an HVAC balance report, in the smoke control / smoke purge mode.
  - 4. The System Status and Programming Report described in NFPA 72. This must be generated on the day of the system acceptance inspection and shall include the measured sensitivity of each smoke detector.
  - 5. The purpose of doing Item above on the day of the inspection is to assure detector sensitivity has not been affected by construction dust. Prudent contractors will have taken measures to prevent detector contamination during construction, and will also have had the system do a detector sensitivity test and

- printout prior to the day of the inspection, to make certain all devices are properly programmed and operating within their limits.
- J After completion of the 100% system test and submission of documentation as described above the installer is to request the engineer to set up an inspection. The system must operate for at least two days prior to this inspection. The responding Fire Department shall be notified of this, for pre-fire planning purposes. On local government projects, local fire authorities may also want to participate in system acceptance inspections. However, for State-owned property they have no inspection jurisdiction and, if present, are only to observe.
- K PRE-FINAL INSPECTION: At the Owner's request and after passing the Designer's pre-final inspection, the Contractor and Manufacturer's authorized installer will conduct system test in the presence of the Owner and the Designer.
- L FINAL INSPECTION: The fire alarm system will be inspected, with portions of it functionally tested. This will normally include the use of appropriate means to simulate smoke for testing detectors, as well as functionally testing the system interface with building controls, fire extinguishing systems and any off-premises supervising station. Operation of any smoke removal system will be checked as instructed by the AHJ. This statistical (sampling) inspection is intended to assure that the contractor has properly installed the system and performed the 100% operational test as required by NFPA 72. The electrical contractor shall provide two-way radios, ladders, and any other materials needed for testing the system, including a suitable smoke source.
1. Smoke control and smoke management systems are normally tested by measuring air flow rates and pressure differentials, plus observing any effect the system has on the operation of exit, elevator, and stairway doors. Testing with smoke "bombs" (smoke candles) is NOT appropriate because they produce cold chemical smoke that lacks buoyancy and, therefore, does not rise like the smoke from a fire.
  2. The test will be conducted entirely by the Contractor. A copy of the final database software must be presented to the Owner before this test. The software shall be loaded from these disks into the system in the presence of the Owner. The review will then be conducted using this software. Any deficiencies shall be recorded and corrected. After the items have been corrected, the system shall be tested again.
    - a. In the event of malfunctions or excessive nuisance alarms, the Contractor must take prompt corrective action. The Owner may require a repeat of the Contractor's 100% system test, or other inspections.
    - b. Test Report: Upon successful completion of the Inspection and after the correction of all efficiencies, the manufacturer's authorized representative shall issue a test report to the Engineer and Owner, detailing and certifying the test.
    - c. System Acceptance: After successful completion of the Final Inspection and recommendation of the Engineer and concurrence of the State Construction Office that all criteria for Final Acceptance have been achieved, the system will be accepted by the Owner. At this time the warranty period begins.

### 3.04 OWNER PERSONNEL INSTRUCTION

- A Provide the following instruction to designated Owner personnel:
1. Hands-On Instruction: On-site, using operational system.
  2. Classroom Instruction: Owner furnished classroom, on-site or at other local facility.
- B Maintenance Technicians: Detailed training for electrical technicians, on programming, maintaining, repairing, and modifying; factory training:
1. Initial Training: Minimum of 8 hours of instruction, pre-closeout.
    - a. Training shall cover at a minimum the following:
      - 1) Preventative maintenance service techniques and schedules, including historical data trending of alarm and trouble records.
      - 2) Overall system concepts, capabilities, and functions. Training shall be in depth, so that owner shall be able to take any device out of service and return any device to service without the need of manufacturer's approval or assistance.
      - 3) Explanation of all control functions, including training to program and operate the software.
      - 4) Methods and means of troubleshooting and replacement of all field wired devices.

- 5) Methods and procedures for trouble shooting the main fire alarm control panel, including field peripheral devices as to programming, bussing systems, internal panel and unit wiring, circuitry, and interconnections.
  - 6) Manuals, drawings, and technical documentation. Actual system software used for training shall be provided in digital form and shall be left with the Owner at the completion of the training for the Owner's use in the future.
- C Furnish the services of instructors and teaching aids; have copies of operation and maintenance data available during instruction.
- D Provide two copies of bound training summary to be referenced by owner's maintenance staff in the future.

### 3.05 CLOSEOUT

- A Closeout Demonstration: Demonstrate proper operation of all functions to Owner.
1. Be prepared to conduct any of the required tests.
  2. Have at least one copy of operation and maintenance data, preliminary copy of project record drawings, input/output matrix, and operator instruction chart(s) available during demonstration.
  3. Have authorized technical representative of control unit manufacturer present during demonstration.
  4. Demonstration may be combined with inspection and testing required by authority having jurisdiction; notify authority having jurisdiction in time to schedule demonstration.
  5. Repeat demonstration until successful.
- B Occupancy of the project will not occur prior to Project Acceptance.
- C Project Acceptance of the project cannot be achieved until inspection and testing is successful and:
1. Approved operating and maintenance data has been delivered.
  2. Spare parts, extra materials, and tools have been delivered.
  3. All aspects of operation have been demonstrated to Owner.
  4. Final acceptance of the fire alarm system has been given by authorities having jurisdiction.
  5. Occupancy permit has been granted.
  6. Specified pre-closeout instruction is complete.

### 3.06 MAINTENANCE

- A Perform routine inspection, testing, and preventive maintenance required by NFPA 72, including:
1. Maintenance of fire safety interface and supervisory devices connected to fire alarm system.
  2. Repairs required, unless due to improper use, accidents, or negligence beyond the control of the maintenance contractor.
  3. Record keeping required by NFPA 72 and authorities having jurisdiction.
- B The manufacturer must maintain software version records on the system installed. The system software shall be upgraded free of charge if a new version is released during the warranty period.
- C Provide trouble call-back service upon notification by Owner:
1. Provide on-site response within 2 hours of notification.
  2. Include allowance for call-back service during normal working hours at no extra cost to Owner.
  3. Owner will pay for call-back service outside of normal working hours on an hourly basis, based on actual time spent at site and not including travel time; include hourly rate and definition of normal working hours in maintenance contract.
- D Provide a complete description of preventive maintenance, systematic examination, adjustment, cleaning, inspection, and testing, with a detailed schedule.
- E Maintain a log at each fire alarm control unit, listing the date and time of each inspection and call-back visit, the condition of the system, nature of the trouble, correction performed, and parts replaced. Submit duplicate of each log entry to Owner's representative upon completion of site visit.
- F Comply with Owner's requirements for access to facility and security.

**END OF SECTION 28 46 00**

**SECTION 28 46 01**  
**FIRE DETECTION AND ALARM - VOICE EVACUATION**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A Fire alarm system design and installation, including all components, wiring, and conduit for the New Gymnasium building as indicated on plans..
- B Transmitters for communication with supervising station.

**1.02 REFERENCE STANDARDS**

- A NFPA 70 - National Electrical Code; National Fire Protection Association, Including All Applicable Amendments and Supplements; 2020.
- B NFPA 72 - National Fire Alarm and Signaling Code; 2013
- C NFPA 101 - Life Safety Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

**1.03 SCOPE**

- A A new complete and fully functional voice evacuation fire alarm and detection system. Contractor shall provide all parts and pieces required to achieve a fully functional system.

**1.04 SUBMITTALS**

- A Proposal Documents: Submit the following with cost/time proposal:
  - 1. NFPA 72 "Record of Completion", filled out to the extent known at the time.
  - 2. Manufacturer's detailed data sheet for each control unit, initiating device, and notification appliance.
  - 3. Certification by Contractor that the system design will comply with the contract documents.
- B Drawings must be prepared using the latest release of ACAD.
- C Evidence of designer qualifications.
- D Design Documents: Submit all information required for plan review and permitting by authorities having jurisdiction, including but not limited to floor plans, riser diagrams, and description of operation:
  - 1. NFPA 72 "Record of Completion", filled out to the extent known at the time.
  - 2. Clear and concise description of operation, with input/output matrix similar to that shown in NFPA 72 Appendix A-7-5-2.2(9), and complete listing of software required.
  - 3. System zone boundaries and interfaces to fire safety systems.
  - 4. Location of all components, circuits, and raceways; mark components with identifiers used in control unit programming.
  - 5. Circuit layouts; number, size, and type of raceways and conductors; conduit fill calculations; spare capacity calculations; notification appliance circuit voltage drop calculations.
  - 6. System response matrix.
  - 7. System riser diagram
  - 8. Battery calculations showing voltage drop after required standby time.
  - 9. List of all devices on each signaling line circuit, with spare capacity indicated.
  - 10. Manufacturer's detailed data sheet for each component, including wiring diagrams, installation instructions, and circuit length limitations.
  - 11. Description of power supplies; if secondary power is by battery include calculations demonstrating adequate battery power.
  - 12. Certification by either the manufacturer of the control unit or by the manufacturer of each other component that the components are compatible with the control unit.
  - 13. Certification by the manufacturer of the control unit that the system design complies with the contract documents.
  - 14. Certification by Contractor that the system design complies with the contract documents.
- E Evidence of installer qualifications.
- F Evidence of instructor qualifications; training lesson plan outline.
- G Evidence of maintenance contractor qualifications, if different from installer.
- H Inspection and Test Reports:
  - 1. Submit inspection and test plan prior to closeout demonstration.
  - 2. Submit documentation of satisfactory inspections and tests.

3. Submit NFPA 72 "Inspection and Test Form," filled out.
- I Operating and Maintenance Data: have one set available during closeout demonstration:
  1. Original copy of NFPA 72 with portions that are not relevant to this project neatly crossed out by hand; label with project name and date.
  2. Complete set of specified design documents, as approved by authority having jurisdiction.
  3. Additional printed set of project record documents and closeout documents, bound or filed in same manuals.
  4. List of recommended spare parts, tools, and instruments for testing.
  5. Replacement parts list with current prices, and source of supply.
  6. Detailed troubleshooting guide and large scale input/output matrix.
  7. Preventive maintenance, inspection, and testing schedule complying with NFPA 72; provide printed copy and computer format acceptable to Owner.
  8. Detailed but easy to read explanation of procedures to be taken by non-technical administrative personnel in the event of system trouble, when routine testing is being conducted, for fire drills, and when entering into contracts for remodeling.
- J Project Record Documents: Have one set available during closeout demonstration:
  1. Complete set of floor plans showing actual installed locations of components, conduit, and zones.
  2. "As installed" wiring and schematic diagrams, with final terminal identifications.
  3. "As programmed" operating sequences, including control events by device, updated input/output chart, and voice messages by event.
  4. Graphic Chart mounted behind plexiglass and secured to wall at FACP and remote annunciator(s). Graphic chart shall indicate all fire alarm devices including the programmed addresses for each device. Frame shall not be removable with standard philips or flat head screw drivers.
  5. A copy of the floor plans with device numbers shall be provided in the control panel. Provide a separate sheet for each floor scaled to be on 11 x17 sheets. All devices shall be clearly labeled and a legend provided on the drawings. Indicate locations of cabinets, modules, and end of line devices. Plans shall be bound and sheets laminated. Provide plan holder in panel or in locked box adjacent to panel keyed to match panel.
  6. Provide CD copy of complete configuration data (site specific programming) for the system submitted to the engineer for distribution to the owner.
  7. Contractor shall provide the following to the owner
    - a. All software required, both for the installed fire alarm system and personal computer necessary to access the fire alarm system for trouble shooting, programming, modifications, monitoring, debugging, or similar functions.
    - b. Complete documentation for all software for both the installed fire alarm system and for any interface PC software necessary for the functions described above.
    - c. Interconnection cable where such is required to connect the fire alarm system to a PC.
- K Closeout Documents:
  1. Certification by manufacturer that the system has been installed in compliance with his installation requirements, is complete, and is in satisfactory operating condition.
  2. NFPA 72 "Record of Completion", filled out completely and signed by installer and authorized representative of authority having jurisdiction.
  3. Certificate of Occupancy.
  4. System Report: Provide Engineer two bound copies of the following for transfer to the owner.
    - a. As-built wiring diagram showing all loop numbers and device addresses, plus terminal numbers and where they connect to control equipment.
    - b. As-built wiring and conduit layout diagrams, including wire color code and/or label numbers, and showing interconnections in the system.
    - c. Electronic circuit diagrams of all control panels, modules, annunciators, communications panels, etc.
    - d. Manufacturer's detailed maintenance requirements.
    - e. Product data on all devices.

- f. As-built calculation sheets showing system capacity and voltage drops.
- L Maintenance Contract: The contractor shall submit a quote for a maintenance contract to provide all maintenance, test, and repair described in this specification and/or in accordance with NFPA 72. Include also a quote for unscheduled maintenance/repair, including hourly rates for technicians trained on this equipment, and response travel costs. Submittals that do not identify all post contract maintenance costs will not be accepted. Rates and costs shall be valid for a period of (5) years after expiration of the guaranty. Maintenance and testing shall be on a semiannual basis or as required whichever is most restrictive. A preventative maintenance schedule shall be provided by the Contractor that shall describe the protocol for preventative maintenance. The schedule shall include:
  - 1. Semiannual systematic examination, adjustment and cleaning of all detectors, manual fire alarm stations, control panels, power supplies, relays, water flow switches and all accessories of the fire alarm system.
  - 2. Semiannual testing of each circuit in the fire alarm system.
  - 3. Semi annual testing of each smoke detector in accordance with the requirements of NFPA 72.
- M Maintenance Materials, Tools, and Software: Furnish the following for Owner's use in maintenance of project.
  - 1. Furnish spare parts of same manufacturer and model as those installed; deliver in original packaging, labeled in same manner as in operating and maintenance data.
  - 2. In addition to the items in quantities indicated in PART 2, furnish the following:
    - a. All tools, software, and documentation necessary to modify the fire alarm system using Owner's personnel; minimum modification capability to include addition and deletion of devices, circuits, and zones, and changes to system description, operation, and evacuation and instructional messages.
    - b. One copy, on CD-ROM, of all software not resident in read-only-memory.
    - c. Extra Fuses: Two for each installed fuse; store inside applicable control cabinet.

#### 1.05 QUALITY ASSURANCE

- A Designer Qualifications: NICET Level III or IV (3 or 4) certified fire alarm technician or registered fire protection engineer, employed by fire alarm control panel manufacturer, Contractor, or installer, with experience designing fire alarm systems in the jurisdictional area of the authorities having jurisdiction.
- B Installer Qualifications: Firm with minimum 5 years documented experience installing fire alarm systems of the specified type and providing contract maintenance service as a regular part of their business.
  - 1. Authorized representative of control unit manufacturer; submit manufacturer's certification that installer is authorized; include name and title of manufacturer's representative making certification.
  - 2. Installer Personnel: At least 2 years of experience installing fire alarm systems.
  - 3. Supervisor: NICET level III or IV (3 or 4) certified fire alarm technician; furnish name and address.
  - 4. Technician must be trained and individually certified by the manufacturer, for the Master Control Unit installed. Training must have occurred within the most recent 24 month. If NICET level III certification shall extend to 36 months.
  - 5. Contract maintenance office located within 50 miles of project site.
  - 6. Certified in the State in which the Project is located as fire alarm installer.
  - 7. Only the installer may make programming changes and must be present at the 100% test, Designer's pre-final review and Owner's final inspection.
- C Maintenance Contractor Qualifications: Same entity as installer or different entity with specified qualifications.
- D Instructor Qualifications: Experienced in technical instruction, understanding fire alarm theory, and able to provide the required training; trained by fire alarm control unit manufacturer.
- E Product Listing Organization Qualifications: Third party agencies shall be amongst those accredited by the NCBC (North Carolina Building Code Council) to label Electrical and Mechanical Equipment.

#### 1.06 WARRANTY

- A Provide control panel manufacturer's warranty that system components other than wire and conduit are free from defects and will remain so for 1 year after Owner's acceptance.

- B Provide installer's warranty that the installation is free from defects and will remain so for 1 year after date of Owner's acceptance.
- C Warranty shall cover all parts and labor required to correct any deficient parts.

## PART 2 PRODUCTS

### 2.01 MANUFACTURERS

- A Addressable Voice analog fire alarm system: Refer to Architects Alternates for Preferred Owner Equipment. Owner's Preferred Fire Alarm System Manufacturer is Notifier.
  - 1. Notifier: NFS2-640/DVC-EM
  - 2. EST.
  - 3. Simplex.
  - 4. Or pre-approved equal.

### 2.02 FIRE ALARM SYSTEM

- A Fire Alarm System: Provide a new automatic one-way voice evacuation fire detection and alarm system:
  - 1. Provide all components necessary, regardless of whether shown in the contract documents or not.
  - 2. Protected Premises: Entire building shown on drawings.
  - 3. Comply with the following; where requirements conflict, order of precedence of requirements is as listed:
    - a. ADA Standards.
    - b. The requirements of the State Fire Marshal.
    - c. The requirements of the local authority having jurisdiction.
    - d. Applicable local codes.
    - e. The contract documents (drawings and specifications).
    - f. NFPA 72; where the word "should" is used consider that provision mandatory; where conflicts between requirements require deviation from NFPA 72, identify deviations clearly on design documents.
  - 4. Evacuation Alarm: Multiple smoke zones; allow for evacuation notification of any individual zone or combination of zones, in addition to general evacuation of entire premises.
  - 5. General Evacuation Zones: Each smoke zone is considered a general evacuation zone unless otherwise indicated, with alarm notification in all zones on the same floor, on the floor above, and the floor below.
  - 6. Hearing Impaired Occupants: Provide visible notification devices in all public areas.
- B Supervising Stations and Fire Department Connections:
  - 1. Public Fire Department Notification: By on-premises supervising station.
  - 2. On-Premises Supervising Station: Existing proprietary station operated by Owner, located at \_\_\_\_\_.
  - 3. Remote Supervising Station: UL-listed central station under contract to facility.
  - 4. Means of Transmission to On-Premises Supervising Station: Directly connected noncoded system.
  - 5. Means of Transmission to Remote Supervising Station: Digital alarm communicator transmitter (DACT), 2 telephone lines. **This New FACP2 shall be interconnected with the existing Notifier NFS-320 FACP1 Panel. The DACT is existing at the FACP 1 Panel and will remain as the means of transmission.**
    - a. The following signals shall be reported as applicable
      - 1) Fire Alarm
      - 2) Sprinkler Waterflow Alarm
      - 3) Carbon Monoxide Alarm
      - 4) Fire Pump Running Alarm
      - 5) Fire Pump Abnormal Status Supervisory Signal
      - 6) Sprinkler Valve Tamper Supervisory Signal
      - 7) Sprinkler Low Temperature / Air pressure supervisory signal
      - 8) Fire Alarm System AC Power Trouble (loss of power for 1 hour or more).
    - b. Sprinkler and fire pump supervisory signals are permitted to be combined by the DACT for transmission. Coordinate with the fire marshal and the supervising station.
    - c. Signal precedence to the supervising station shall be per NFPA 72 and as defined below.

- 1) Fire Alarm
  - 2) Carbon Monoxide Alarm
  - 3) Supervisory Signal
  - 4) Trouble Signal
  - 5) Security Alarm
- d. The contractor must provide a DACT that is compatible with the supervising station. Coordinate with the supervising station prior to ordering and installing DACT. Contractor shall verify proper signal receipt with supervising station and ensure compliance with NFPA 72.
- C Circuits:
1. Initiating Device Circuits (IDC): Class A.
  2. Signaling Line Circuits (SLC): Class A with no T taps.
  3. Notification Appliance Circuits (NAC): Class B.
  4. Voice Signal Circuits: Class B
- D Spare Capacity:
1. Initiating Device Circuits: Minimum 25 percent spare capacity.
  2. Notification Appliance Circuits: Minimum 25 percent spare capacity.
  3. Speaker Amplifiers: Minimum 25 percent spare capacity.
  4. Master Control Unit: Capable of handling all circuits utilized to capacity without requiring additional components other than plug-in control modules.
- E Power Sources:
1. Primary: Dedicated branch circuits of the facility power distribution system.
  2. Secondary: Storage batteries.
  3. Capacity: Sufficient to operate entire system for period 60 hours in standby with 15 minutes of full alarm at the end of the 60 hours..

### 2.03 FIRE SAFETY SYSTEMS INTERFACES

- A Supervision: Provide supervisory signals in accordance with NFPA 72 for the following:
1. Sprinkler water control valves.
  2. Fire pump(s).
- B Alarm: Provide alarm initiation in accordance with NFPA 72 for the following:
1. Sprinkler water flow.
  2. Kitchen hood suppression activation; also disconnect fuel source from cooking equipment.
  3. Duct smoke detectors.
- C HVAC:
1. Duct Smoke Detectors: Close dampers indicated; shut down air handlers indicated.
- D Doors:
1. Smoke Barrier Door Magnetic Holders: Release upon activation of smoke detectors in smoke zone on either side of door, upon alarm from manual pull station on same floor, and upon sprinkler activation on same floor. Refer to Section 08 71 00. Door hold open magnets may release 60 seconds after loss of 120V power.
- E Sprinkler System Monitoring
1. The following sprinkler system alarm and supervisory functions shall be provided as part of the fire alarm system:
    - a. Waterflow alarm, by sprinkler zone (not to exceed one floor).
    - b. Supervision of each control valve.
    - c. Supervision of air pressure, if used.
    - d. Supervision of fire pump.
  2. Sprinkler supervisory monitoring of flow switches, tamper switches, and similar functions shall be accomplished with a separate system address for each activity monitored.
  3. Contractor shall be responsible for reviewing the fire protection drawings and providing the quantity of tamper switches, flow switches, air pressure sensors, monitor and relay modules as required by the fire protection system design.



## 2.04 COMPONENTS

### A General:

1. Provide flush mounted units where installed in finish areas; in unfinished areas, surface mounted unit are acceptable.
2. Provide legible, permanent labels for each control device, using identification used in operation and maintenance data.
3. Consult with facility manager and local fire official prior to locating Master Control Unit, remote annunciator, or system printer.
4. System Capacity and General Operation: The system shall have the following capacities and general operation modes:
  - a. The FACP shall provide, or be capable of expansion to 198 intelligent/addressable devices per Signaling Line Circuits (SLC) and 2000 annunciation points, minimum, per system. The number of SLCs provided shall be as indicated on the Drawings. Total points shall be as indicated on the drawings or otherwise specified.
  - b. The FACP shall include a full featured operator interface control and annunciation panel that shall include a backlit, 80 minimum character liquid crystal display, individual, color coded system status LEDs, and an alphanumeric keypad for the field programming and control of the fire alarm system.
  - c. All programming or editing of the existing program in the system shall be achieved without special equipment and without interrupting the alarm monitoring functions of the fire alarm control panel.

### B Fire Alarm Control Units, Initiating Devices, and Notification Appliances: Analog, addressable type; listed, classified, and labeled as suitable for the purpose intended.

### C Master Control Unit shall have the following features:

1. The system shall be addressable type, with 24vdc nominal operating voltage.
2. Upload/Download to PC Computer
3. Charger Rate Control
4. Drift Compensation
5. Automatic Day/Night Sensitivity Adjust
6. Device Blink Control
7. Pre-alarm Control Panel Indication
8. Trouble Reminder
9. NFPA 72 Smoke Detector Sensitivity Test
10. System Status Reports
11. Periodic Detector Test
12. Alarm Verification, by device, with tally
13. Non-Alarm Module Reporting
14. Block Acknowledge
15. Smoke Detector Maintenance Alert
16. Control-By-Time
17. The control panel shall be capable of printing historical data and device parameters and shall include all equipment necessary to produce printouts, including an external printer and shall be U.L. listed as meeting the NFPA 72 sensitivity testing and maintenance requirements without the need for manually removing and testing each smoke detector. The control panel shall provide a display and a printed list of these sensitivity measurements as a permanent record of the required sensitivity testing. The system shall also annunciate a trouble condition when any smoke detector approaches 80% of its alarm threshold due to gradual contamination, with an annunciation of the location of the smoke detector requiring service. If any specialized equipment must be used to program any function of the smoke detector devices, then one must be furnished as part of the system.
18. The system shall perform time based control functions including automatic changes of specified smoke detector sensitivity settings.

19. System shall provide as a feature an alternate signal processing algorithm to verify the presence of smoke. The algorithm shall be selectable during system programming. The total effective delay created by the verification algorithm shall not exceed 60 second.
  20. Audible evacuation signals
    - a. Speakers shall be capable of generating a temporal three alarm as well as voice messages as required.
    - b. Panel shall operate in one of the three evacuation signal modes identified below:
      - 1) Automatic: System operates in its pre-programmed mode with temporal three alarm and pre-recorded message.
      - 2) Manual: System activates temporal three alarm and pre-recorded message based on manual activation at the main panel.
      - 3) Paging: The temporal three alarm will sound continuously until the microphone button at the main panel or remote annunciator is pressed for a live voice message. Once button is released the temporal 3 alarm will resume.
    - c. Provide zone selector switches so that any or all voice evacuation zones may be manually paged at a time.
    - d. At a minimum the voice alarm zone shall be as described below. Coordinate with local fire marshal for additional zone requirements.
      - 1) Each Individual Floor
      - 2) Each Stairwell
      - 3) Elevator Lobbies/Area of Rescue Assistance
      - 4) Elevator Cabs
  21. A hand-held push to talk microphone with minimum of 5 foot coiled extension cable. Microphone shall be recessed in the main fire alarm panel enclosure.
- D Central Processing Unit: The Central Processing Unit (CPU) shall communicate with, monitor, and control all other modules within the control panel. Removal, disconnection or failure of any control panel module shall be detected and reported to the system display by the CPU.
1. The CPU shall contain and execute all control-by-event (including ANDing, ORing, NOTing, CROSSZONEing) programs for specific action to be taken if an alarm condition is detected by the system. Such control-by-event programs shall be held in non-volatile programmable memory, and shall not be lost with system primary and secondary power failure. The CPU shall also provide a real-time clock for time annotation of all system displays. The Time-of-Day and date shall not be lost if system primary and secondary power supplies fail.
  2. Digitized electronic signals shall employ check digits or multiple polling. In general a single ground or open on any system signaling line circuit or initiating device circuit shall not cause system malfunction, loss of operating power or the ability to report an alarm.
  3. The CPU shall be capable of being programmed on site without requiring the use of any external programming equipment. Systems that require the use of external programmers or change of EPROMs are not acceptable.
  4. Loss of power: Alarm signals arriving at the main FACP shall not be lost following a power failure (or outage) until the alarm signal is processed and recorded.
  5. The system shall have multiple access levels so owner's authorized personnel can disable individual alarm inputs or normal system responses (outputs) for alarms, without changing the system's executive programming or affecting operation of the rest of the system. The process on how to do this must be included in the training required to be given to the owner's designated personnel, and must also be part of the written documentation provided by the fire alarm equipment supplier.
- E System Response Conditions.
1. Alarm Condition - When a fire alarm condition is detected and reported by one of the system initiating devices, the following functions shall immediately occur:
    - a. The system alarm LED shall flash.
    - b. A local piezo-electric signal in the control panel shall sound.

- c. LCD display shall indicate all information associated with the fire alarm condition, including the type of alarm point and its location.
  - d. On systems equipped with a printer, printing and history storage shall log the information associated with each new fire alarm signal, along with the time and date of occurrence.
  - e. All system outputs assigned via control-by-event equations to be activated by a particular point shall be executed.
  - f. Activate all fire alarm Notification Appliances.
  - g. Activate IP digital alarm communicator.
  - h. Deactivate all door hold control relays.
  - i. Activate control relays to initiate AHU shutdown.
  - j. In buildings with elevators, activate elevator recall sequence when elevator initiating device is activated.
2. Trouble or Supervisory Condition - When a trouble condition is detected the following stipulations apply:
- a. System AC power trouble shall not be sent unless maintained for 3 hours or more. Provide additional relays as required for this purpose.
  - b. Provide adjustable time delay for all other trouble signals prior to transmission.
  - c. Supervise all initiating, signaling, and notification circuits throughout the facility by way of monitor and control modules.
  - d. Visually and audibly annunciate any trouble, supervisory condition on operator's terminals, panel display, and annunciators.
- F Operators Control: Provide an operators interface which allows the following minimum functions. In addition, the operators interface shall support any other functions required for system control and/or operation:
1. Acknowledge (ACK/STEP) Switch
  2. Signal Silence Switch
  3. Alarm Silence Switch
  4. System Reset Switch
  5. System Test Switch
  6. Lamp Test Switch
  7. Elevator Recall Override Switch.
  8. AHU Shutdown Override Switch.
- G Display: The system display shall provide all the controls and indicators used by the system operator and may also be used to program all system operational parameters. The display assembly shall contain, and display as required, custom alphanumeric labels for all intelligent detectors, addressable modules, and software zones.
1. The system display shall provide an 80 minimum-character back-lit alphanumeric Liquid Crystal Display (LCD).
  2. The Display shall also provide four Light-Emitting-Diodes (LEDS), that will indicate the status of the following system parameters: AC POWER, SYSTEM ALARM, SYSTEM TROUBLE, and SIGNAL SILENCE.
  3. The system display shall provide a touch key-pad with control capability to command all system functions, entry of any alphabetic or numeric information, and field programming. Two different password levels shall be accessible through the display interface assembly to prevent unauthorized system control or programming.
- H Printer: For systems exceeding 100 addressable points, 3 occupied floors in height, or 60,000 square feet, Provide a printer to provide hard-copy printout of all changes in status of the system. The printers shall time stamp such printouts with the current time-of-day and date. The printer shall be standard carriage with 80 characters per line and shall use standard pin-feed paper. Thermal printers are not acceptable. The printer shall operate from a 120V, 60 Hz power source. Provide a table and stand for printer in main data room.
- I Remote Annunciators: Annunciator shall communicate with the fire alarm control panel via an EIA-485 communications loop (four-wire) and shall individually annunciate all zones in the system. System zones

shall be as indicated on the Drawings. Up to 10 annunciators may be co.

1. Annunciator shall be capable of initiating manual paging to override the pre-recorded message. Provide individual speaker zone selector switches so that the first responder may select some or all of the zones to manually page at a time.
2. Annunciator Indicators: The annunciator shall provide a red Alarm LED per zone, and a yellow Trouble LED per zone. The annunciator shall also have an "ON-LINE" LED, local piezo sounder, local acknowledge/lamp test switch, and custom zone/function identification labels. Annunciator switches may be used for System control such as, Global Acknowledge, Global Signal Silence, Alarm Resound, and Global System Reset. All annunciator switches and indicators shall be software programmable.
3. LCD Alphanumeric Display Annunciator: The Alphanumeric Display Annunciator shall be a supervised, remotely located back-lit LCD display containing a minimum of eighty (80) characters for alarm annunciation in clear English text. The LCD Annunciator shall display all alarms and trouble conditions in the system.
4. System Capacity: The system shall allow a minimum of four LCD annunciators. In addition to annunciation functions, each LCD annunciator shall be capable of the following software programmed system functions: Acknowledge, Signal Silence, Alarm Resound, and Reset.
5. Connections: The annunciator shall connect to a two-wire EIA-485 interface. The two-wire connection shall be capable operation at distances of 6,000 feet. Provide interface to fiber optic cable systems and/or repeater units where such are indicated on the Drawings.
6. Annunciator shall be equipped with a hand-held push to talk microphone with minimum of 5 foot coiled extension cable. Microphone shall be recessed in the main fire alarm panel enclosure.

J Initiating Devices:

1. Addressable Devices - General: All initiating devices shall be individually addressable. Addressable devices shall comply with the following requirements:
  - a. All addressable spot type and duct smoke detectors shall be the analog type and the alarm system shall automatically compensate for detector sensitivity changes due to ambient conditions and dust build-up within detectors. This feature must be armed and sensitivities set prior to acceptance of the system.
  - b. Address Setting: Addressable devices shall provide an address-setting means.
  - c. Connections: Addressable devices shall be connected to a Signaling Line Circuit (SLC) with two (2) wires.
  - d. Operational Indications: Addressable initiation devices shall provide dual alarm and power LEDs. Both LEDs shall flash under normal conditions, indicating that the device is operational and in regular communication with the control panel. Both LEDs shall be placed into steady illumination by the FACP to indicate that an alarm condition has been detected. The flashing mode operation of the detector LEDs shall be optional through the system field program. An output connection shall also be provided in the device base to connect an external remote alarm LED.
  - e. Intelligent Initiation Devices: All smoke detectors shall be the "intelligent" in that smoke detector sensitivity shall be set through the FACP and shall be adjustable in the field through the field programming of the system. Sensitivity shall be capable of being automatically adjusted by the FACP on a time-of-day basis. Using software in the FACP, detectors shall be capable of automatically compensating for dust accumulation and other slow environmental changes that may affect performance. The detectors shall be listed by UL as meeting the calibrated sensitivity test requirements of NFPA Standard 72.
  - f. Spot-type detectors must be the plug-in type, with a separate base (not a mounting ring), to facilitate their replacement and maintenance. The base shall have integral terminal strips for circuit connections, rather than wire pigtailed. Each detector or detector base shall incorporate an LED to indicate alarm.
2. Smoke Detectors General Requirements:
  - a. Spot-type detectors must be the plug-in type, with a separate base (not a mounting ring), to facilitate their replacement and maintenance. The base shall have integral terminal strips for

- circuit connections, rather than wire pigtails. Each detector or detector base shall incorporate an LED to indicate alarm.
- b. Device mounting Base: Unless otherwise specified all detectors shall be ceiling-mount and shall include a separate twist-lock base with locking tamper proof feature.
  - c. Sounder Base: Where indicated on plans provide bases with a built-in (local) sounder rated at 85 dBA minimum, measured at 10 ft. Configure sounder bases such that sounders are activated under conditions as described in the Matrix.
  - d. Test Means: The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself (by activating a magnetic switch) or initiated remotely on command from the control panel when in the "test" condition.
  - e. Device Identification: Detectors shall store an internal identifying type code that the control panel shall use to identify the type of device. Device identifications shall be either ION, PHOTO, or THERMAL.
  - f. Photoelectric Smoke Detectors: Photoelectric smoke detectors shall use the photoelectric (light-scattering) principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density.
  - g. Ionization Smoke Detector: Ionization smoke detectors shall use the dual-chamber ionization principal to measure products of combustion and shall, on command from the control panel, send data to the panel representing the analog level of products of combustion.
3. Thermal Detectors: Thermal Detectors shall be intelligent addressable devices rated at 135°F (58°C) and shall have a rate-of-rise element rated at 15° F. (9.4°C) per minute. It shall connect via two wires to the Fire Alarm Control Panel Signaling Line Circuit. Up to 99 intelligent heat detectors may connect to one SLC loop. Thermal detectors shall use an electronic sensor to measure thermal conditions caused by a fire and shall, on command from the control panel, send data to the panel representing the analog level of such thermal measurements.
  4. Duct Smoke Detector: In-Duct Smoke Detector Housings shall accommodate a velocity rated photoelectric detector. The device, independent of the type used, shall provide continuous analog monitoring and alarm verification from the panel. When sufficient smoke is sensed, an alarm signal shall be initiated at the FACP. Proper installation and physical location of each duct detector and access door shall be coordinated between the electrical, the mechanical and the fire alarm sub-contractors and approved by the electrical and mechanical engineers prior to equipment installation.
    - a. Each Duct detector shall have a hinged duct access panel, 12 x 12 inches minimum for sampling tube inspection and cleaning. Indicate airflow direction on the duct adjacent to detector using permanent decal.
    - b. Duct detector sampling tubes shall extend the full width of the duct. Sampling tubes over 36 inches long must be provided with far end support for stability. Install sampling tube per manufacturer's instructions.
    - c. All duct detectors shall be programmed for alarm.
  5. Remote annunciator Indicator Lights (RAIL): RAILS shall be provided for initiating devices where indicated on the plans. RAILS shall be provided with a key type switch for testing of the annunciated device. All RAILS shall be 24 VDC.
  6. Addressable Pull Stations - General: Addressable pull stations shall, on command from the Control Panel, send data to the panel representing the state of the manual switch. They shall use a key operated test-reset lock, and shall be designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key. All pull stations shall be dual-action, have a positive, visual indication of operation and utilize a key type reset. The Glass-break rods are not allowed.
- K Notification Appliances:
1. Speakers: Speakers located outdoors or in damp or wet locations shall be listed for use in wet locations. Electric speakers shall operate with synchronized audible output and have the following specifications: .
    - a. Voltage: Programmable electronic speakers shall operate on dual voltage 24/70 VRMS nominal.

- b. Ceiling speakers: 8" round, field selectable taps 1/8 to 8 watts.
  - c. Ceiling speaker/strobes: 8" round, field selectable taps 1/8 to 8 watts, field selectable candela settings 15-177 CD
  - d. Cluster speakers/strobe: equal to Cooper Wheelock Series STH or equal.
  - e. Wall Mounted Speakers: Selectable taps 1/8 to 8 watts, frequency response 400-4000Hz and low current design, when used in exterior application provide as weatherproof.
  - f. Speakers shall be tapped to meet intelligibility criteria meeting average DB requirements of 15DB above ambient for each space. The adjustments shall also meet the Acoustically Distinguished Space (ADS) measurement STI/CIS range (good-excellent).
  - g. Programming: Electronic speakers shall be field programmable without the use of special tools. Speakers shall be adjustable from 0.25 to 2.0 Watts.
  - h. Provide 1 extra.
  2. Speakers: : Speakers, where provided, shall have audible sound with taps at 1/4 watt, 1/2 watt, 1 watt, 2 watt. Speakers shall operate at 24V. Provide back boxes for all speakers. Speakers shall be tapped at 1 watt for design purposes.
    - a. Provide 1 extra.
  3. Strobes: shall be located as shown on the Drawings and provided per the requirements of the NCSBC chapter #11 and ICC A117.1-2009. Strobe lights indicated for use exterior to the building shall be mounted at the indicated elevation and listed for use in wet locations. Strobe lights shall operate with synchronized flash output and have the following specifications:
    - a. Voltage: Strobe lights shall operate on 24 VDC nominal.
    - b. Maximum pulse duration: 2/10ths of one second.
    - c. Strobe intensity and flash rate: Must meet minimum requirements of UL 1971. Provide strobe lights with minimum intensity Candela (Cd) rating of 15/75 Cd, or greater if shown otherwise on drawings.
  4. Audible/Visual Combination Devices shall comply with all applicable requirements for both Programmable Electronic Sounders and Strobe Lights.
  5. Bells shall be 10" diameter vibrating type located as shown on the Drawings; bells located outdoors shall be listed for use in wet locations. Bells shall have the following specifications:
    - a. Voltage: Bells shall operate on 120 V normal.
- L Miscellaneous System Items
1. Addressable Dry Contact Monitor Module: Addressable Monitor Modules shall be provided to connect one supervised zone of non-addressable Alarm Initiating Devices (any Normally Open [N.O.] dry contact device) to one of the Fire Alarm Control Panel Signaling Line Circuit Loops. Monitor modules shall be installed as required by the system configuration. All required monitor modules may not be shown on the Drawings.
    - a. Indication of Operation: An LED shall be provided that shall flash under normal conditions, indicating that the Monitor Module is operational and in regular communication with the control panel.
    - b. Supervision: Unless specifically noted otherwise on the drawings provide one monitor module for each sprinkler switch.
  2. Two Wire Detector Monitor Module: Addressable Monitor Modules shall be provided to connect one supervised IDC zone, Class A or alarm initiating devices (any N.O. dry contact device) to one of the Fire Alarm Control Panel Signaling Line Circuit Loops. Monitor modules shall be installed as required by the system configuration. All required monitor modules may not be shown on the Drawings. Indication of Operation: Unless otherwise indicated on the Drawings an LED shall be provided that shall flash under normal conditions, indicating that the Monitor Module is operational and in regular communication with the control panel.
  3. Addressable Control Module: Addressable Control Modules shall be provided to supervise and control the operation of one conventional Notification Appliance Circuit (NAC) of compatible, 24 VDC powered, polarized Audio/Visual (A/V) Notification Appliances. For fan shutdown and other auxiliary control functions, the control module may be set to operate as a dry contract relay. The control module

- shall provide address-setting means using DIP switches and shall also store an internal identifying code that the control panel shall use to identify the type of device. An LED shall be provided that shall flash under normal conditions, indicating that the control module is operational and is in regular communication with the control panel.
- a. Configuration: The control module NAC circuit may be wired for Class B with up to 1 Amp of inductive A/V signal, or 2 Amps of resistive A/V signal operation, or as a dry contact (Form C) relay. The control module shall be suitable for pilot duty applications and rated for a minimum of 0.6 amps at 30 VDC. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to insure that 100% of all auxiliary relay or NACs may be energized at the same time on the same pair of wires.
  - b. Power Source: Audio/visual power shall be provided by a separate supervised power loop from the main fire alarm control panel or from a supervised, 3rd party listed remote power supply. AN power sources and connections are not shown on the Drawings
  - c. Test Switch: A magnetic test switch shall be provided to test the module without opening or shorting its NAC wiring.
4. Isolator Module: Isolator Modules shall be provided to automatically isolate wire-to-wire short circuits on an SLC loop. The Isolator Module shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the SLC Loop. Modules must be readily accessible (not above ceiling) and clearly labeled.
- a. Operation: Isolator Modules shall operate such that if a wire-to-wire short occurs, the Isolator module shall automatically open-circuit (disconnect) the SLC loop. When the short circuit condition is corrected, the Isolator Module shall automatically reconnect the isolated section. The Isolator Module shall not require any address-setting, and its operations shall be totally automatic. It shall not be necessary to replace or reset an Isolator Module after its normal operation.
  - b. The Isolator Modules shall provide a single LED that shall flash to indicate that the Isolator is operational and shall illuminate steadily to indicate that a short circuit condition has been detected and isolated.
  - c. Isolation modules must be provided in the following locations as a minimum.
    - 1) Immediately adjacent to the Main Fire Alarm Control Unit, at each end of the addressable loop. These two isolators must be within 15 feet of the Main Fire Alarm Control Unit.
    - 2) After each 20 initiating devices and control points on the addressable loop.
    - 3) For loops with 20 or less control points install isolation module in approximately the middle of the loop.
    - 4) Near the point where any addressable loop extends outside the building envelope.
    - 5) For loops covering more than one floor where addressable loop crosses between floors.
  - d. Each isolation module must be clearly labeled, readily accessible for convenient inspection.
5. Water Flow Switch: Flow switches shall be integral, mechanical, non-coded, non-accumulative retard type. Flow switches shall have an alarm transmission delay time that is conveniently adjustable from 0 to 60 seconds. Initial settings shall be 30-45 seconds. Flow switches shall be located a minimum of one (1) foot from a fitting that changes the direction of the flow and a minimum of three (3) feet from a valve as required per NFPA 13. Installation: Water Flow Switches shall be connected by the Division 26 (Electrical) Contractor but furnished and installed by the Division 23 (Mechanical) Contractor.
6. Sprinkler and Standpipe Valve Supervisory Switch: Supervisory switch mechanisms shall be contained in a weatherproof housing that shall provide a 3/4 inch tapped conduit entrance and shall incorporate the necessary facilities for attachment to the valves. Switch housing shall be finished in red baked enamel. Mounting: Mount switch so as not to interfere with the normal operation of the valve and adjust to operate within two revolutions toward the closed position of the valve control, or when the stem has moved no more than one-fifth of the distance from its normal position.
7. Remote Annunciator Indicator Lights (RAIL): RAILS shall be provided with a key type switch for testing of the annunciated device. In addition, RAILS shall have the following features: Voltage: RAILS shall operate on 24 VDC nominal.
8. Door Hold-Open magnets:

- a. Door hold open magnets shall be suitable for mounting in a single gang electrical device box.
  - b. Door hold open magnets shall be furnished with keepers, door chains, and other accessories as required to properly hold open doors as indicated on the Drawings.
  - c. Wall mounted magnetic door holders and separate heavy duty closers shall be used instead of combination door control units.
  - d. Holding force of the magnet shall be appropriate for the door to be held open. Door hold open magnets shall operate in a fail safe manner, i.e., the door shall release in event of a failure of voltage to the device.
  - e. Power Source: Door hold open magnets shall be configured to operate from a nominal 24 VDC system as supplied by the FACP or other power supply listed for the purpose.
  - f. All hold open magnet supply sources, whether a part of the FACP or whether derived from a separate power supply, shall be supervised.
  - g. Door hold open magnet circuits which use step-down transformers, 120 VAC, or local relays are not permitted.
  - h. Door shall close after 60 seconds of the power loss.
9. Battery Power Supply (BPS) &/or Supplementary Notification Appliance Circuit (SNAC): These types of panels shall be completely maintenance free, shall not require liquids, fluid level checks or refilling, and shall not be capable of producing spills and/or leaks. Batteries shall be sealed gel-cell type with expected life of 10 years. Battery voltage shall be as required by the FACP and related equipment. Battery shall have sufficient capacity to power the fire alarm system for not less than 60 hours plus 15 minutes of alarm upon a normal AC power failure. Battery cabinet shall be twice the size of the batteries it will contain. NAC circuits shall not exceed 75% of maximum current load allowed.
- a. The voltage drop at EOL must not exceed 14% of the expected battery voltage after the required standby and alarm times. Determine worst case voltage at far end of each NAC circuit. The results must not be than the minimum listed rating on the device.
  - b. Where voltage drop or capacity limits are exceeded provide additional NAC panels as required for a fully functional system.
  - c. All power supplies shall be capable of withstanding prolonged short circuits in the field wiring, either line-to-line or line-to-ground, without damage.
  - d. All power supplies shall be equipped with battery charging using dual-rate charging techniques for fast battery recharge.
10. Voice Amplifier Cabinets
- a. Provide voice amplifier cabinets as identified on plans and as need to support the number of devices shown on the drawings. All amplifier cabinets shall be UL listed to operate with the system provided. Amplifier cabinets shall work in conjunction with the NAC panels and control panels to form a complete system.
  - b. Provide a minimum of 25% spare amplifier capacity for future growth.
11. Enclosure: All equipment enclosures shall be third party listed suitable for surface or semi-flush mounting. Cabinet and front shall be corrosion resistant, given a rust-resistant prime coat, and manufacturer's standard finish. The door shall provide a key lock and a glass opening for viewing indicators. Door hinge shall be field selectable (left or right).
- M Wiring
1. Addressable loop (signaling line) circuits shall be wired with type FPL/FPLR/FPLP fire alarm cable, AWG 18 minimum, low capacitance, twisted shielded copper pair. Cable shield drain wires are to be connected at each device on the loop to maintain continuity, taped to insulate from ground, and terminated at the FACP. Acceptable cables include Atlas 228-18-1-1STP, BSCC S1802s19 (same as EEC 7806LC), West Penn D975, D991 (AWG 16), D995 (AWG 14), or equal wire having capacitance of 30pf/ft. maximum between conductors. Belden 5320FJ acceptable if only FPL rating needed.
    - a. Unshielded cable, otherwise equal to the above, is permitted to be used if the manufacturer's installation manual requires, or states preference for, unshielded cable.
    - b. In underground conduit, use Type TC or PLTC cable (PE insulated) to avoid problems from moisture.



- c. The following conductor color coding shall be maintained throughout the system:
  - 1) Initiating Circuits: Red (+)/White (-)
  - 2) Initiating Circuits, Smoke Only: Violet (+)/Grey (-)
  - 3) Signal Line Circuits: Red jacket with Red (+)/Black(-)
  - 4) Alarm Indicating Appliance Circuits: Blue (+)/Black(-)
  - 5) AHU Shutdown Circuits: Yellow (+)/Brown (-)
  - 6) Door Control Circuits: Orange
  - 7) Elevator Capture Circuits: Brown
- 2. All voice signal cabling shall be a minimum of #18 AWG twisted shielded pair cable. The shield shall be continuously connected from the amplifiers to the end of line.
- 3. Supervision must be provided between individual addressable modules and their associated contact type initiating devices.
- N Surge Protection: In accordance with IEEE C62.41.2 category B combination waveform and NFPA 70; except for optical fiber conductors.
  - 1. For each AC power circuit that interfaces with fire alarm equipment install an AC suppressor in a listed enclosure near the electrical panelboard, and trim excess lead lengths. Wind small coil in the branch circuit conductor just downstream of the suppressor connection. Coil to be 5 to 10 turns, about 1" diameter, and securely tie-wrapped. This series impedance will improve the effectiveness of the suppressor in clipping fast rise time voltage transients.
  - 2. Equipment Connected to Alternating Current Circuits: Maximum let through voltage of 350 V(ac), line-to-neutral, and 350 V(ac), line-to-line; do not use fuses.
  - 3. Initiating Device Circuits, Notification Appliance Circuits, and Communications Circuits: Provide surge protection at each point where circuit exits or enters a building; rated to protect applicable equipment; for 24 V(dc) maximum dc clamping voltage of 36 V(dc), line-to-ground, and 72 V(dc), line-to-line.
  - 4. On DC circuits extending outside the building: Provide surge protection at each point where circuit exits or enters a building, rated to protect applicable equipment.
- O Locks and Keys: Deliver keys to Owner.
  - 1. Provide the same standard lock and key for each key operated switch and lockable panel and cabinet; provide 5 keys of each type
- P Instruction Charts: Printed instruction chart for operators, showing steps to be taken when a signal is received (normal, alarm, supervisory, and trouble); easily readable from normal operator's station.
  - 1. Frame: Stainless steel or aluminum with polycarbonate or glass cover.
  - 2. Provide one for each control unit where operations are to be performed.
  - 3. Obtain approval of Owner prior to mounting; mount in location acceptable to Owner.
  - 4. Provide extra copy with operation and maintenance data submittal.
- Q SPARE PARTS:
  - 1. The following spare parts shall be provided with the system. For multi-building projects, calculate quantities separately for each building that contains a dedicated fire alarm control panel. If FACP also serves auxiliary buildings (e.g., storage, boiler/chiller), calculate as if one building. Increase decimal quantities to the next higher whole number.
    - a. • Fuses (If Used) 2 of each size in system
    - b. Manual Fire Alarm Boxes 2% of installed quantity
    - c. Addressable Control Relays 4% of installed quantity
    - d. • Indoor Horns/Speakers with Strobes Lights 4% of installed quantity
    - e. Indoor Strobe-only Notification Appliances 4% of installed quantity
    - f. Monitor Modules (Addressable Interface) 4% of installed quantity
    - g. Isolation Modules I Isolation Bases 4% of installed quantity
    - h. Addressable, Electronic Heat Detectors 4% of installed quantity
    - i. • Spot-Type Smoke Detectors I Sounder Bases 6% of installed quantity
    - j. \* No spares are required for projected beam, air sampling, or duct smoke detectors

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A Install in accordance with applicable codes, NFPA 72, NFPA 70, and the contract documents.
- B Conceal all wiring, conduit, boxes, and supports where installed in finished areas.
- C All equipment supplied must be specifically listed for its intended use and shall be installed in accordance with the manufactures recommendations. The contractor shall consult the manufacturer's installation manuals for all wiring diagrams, schematics, physical equipment sizes, etc., before beginning system installation. Contractor shall refer to the Riser/Connection diagram for all specific system installation/termination/wiring data.
- D All system components shall be attached to walls and ceiling/floor assemblies and shall be held firmly in place (e.g., detectors shall not be supported solely by suspended ceilings). Fasteners and supports shall be adequate to support the required load. Adhesives are not permitted to mount fire alarm system components to building surfaces or structure.
- E The system shall be electrically supervised for open or ground fault conditions in SLC, alarm, voice, and control circuits. Removal of any detection device, alarm appliance, plug-in relay, system module, or standby battery connection shall also result in a trouble signal.
- F When programming the system, activate the automatic drift compensation feature for all spot- type smoke detectors. Systems with alarm verification are not to have this feature activated without written direction from the owner's representative or the AHJ. Alarm verification must not be used with multi-sensor/multi-criteria detectors under any circumstances, as inadequate system response may result. Most applications of analog addressable smoke detectors do not require alarm verification to reduce nuisance alarms, as they are better able to discriminate between fire and common non-fire ambient events. A short operational test with normal occupancy can determine if transient ambient events are a problem
- G Provide photoelectric smoke detector within 15 feet of every Fire Alarm Control Panel, NAC Panel or other fire alarm control equipment. These detectors shall be provided weather shown on plans or not.
- H Set spot-type smoke detector sensitivities to normal/medium, unless directed otherwise by the design engineer/owner's rep. High sensitivity may be appropriate in relatively benign, clean environments such as art museums and libraries, to improve system response time without causing nuisance alarms.
- I Unless suitably protected against dust and other debris, spot type smoke detectors shall not be installed until final construction clean-up has been completed. In the even that detectors are damaged during construction due to failure to adequately protect devices, they shall be replaced by the contractor at no expense to the owner.
- J Print a complete System Status and Programming Report after the above steps have been done. This must include the program settings for each alarm initiating device and the current sensitivity of each analog addressable smoke detector.
- K Install instruction cards and labels.
- L Basic operating instructions shall be framed and permanently mounted at the Main Control Unit. The NFPA 72 record of completion must either be kept at the Main Control Unit or an alternate location may be permanently engraved at the Main Control Unit.
- M Provide engraved label at the Main Control Unit and secondary power supplies identifying the 120V power source including panelboard location, panelboard identifier, and branch circuit number.
- N Breaker serving fire alarm power supplies shall be protected with a fire alarm handle lock, Space Age Electronics ELOCK series or approved equal. Additionally the breaker handle shall be labeled with 1/4" permanent red dot.
- O Identification of individual initiating devices is required. Assign each initiating device a unique number as follows, sequence starting from the FACP: (Addressable Loop # -- Device #). Show device numbers on as built plans and permanently mark each detector base so that it is readable on the floor below without having to remove detector. Labels must be typewritten with black lettering and clear background.

### **3.02 CONDUIT AND WIRING**

- A All fire alarm system wiring shall be in metal conduit, minimum 3/4", or surface metal raceway. All fire alarm system raceway, couplers, and connectors must meet performance and installation requirements as identified in other sections of this specification manual.

- B Detection or alarm circuits must not be included in raceways containing AC power or AC control wiring. Within the Fire Alarm Control Panels, and 120V control wiring or other circuits must with an externally supplied voltage above 24 V must be properly separated from other circuits and have the appropriate warning label to alert service personnel to the potential hazard.
- C There shall be no splices in the system other than at device terminal blocks, or on terminal blocks in cabinets.
- D Permanent wire markers shall be used to identify all connections in the Main Fire Alarm Control Unit and other control equipment, at power supplies and terminal cabinets.
- E In multistory buildings, all circuits leaving the riser on each floor shall feed through a labeled terminal block in a hinged enclosure accessible from the floor.
- F All wiring terminal block screws shall have pressure wire connectors of the self-lifting or box lug type.
- G All wiring shall be checked for grounds, opens, and shorts, prior to termination at panels and installation of detector heads. The minimum allowed resistance to ground between any two conductors shall be 10 megohms, as verified with an insulation resistance test. Provide Engineer with the results of these tests.
- H The exterior of all junction boxes, including both sides of covers, containing fire alarm conductors shall be painted red. Box interior shall not be painted.
- I Box covers shall be labeled to indicate the circuit(s) or function of the conductors contained within. Labels shall be neatly applied black lettering on clear background. Handwritten labels or embossed tape labels are not allowed.
- J All conduits penetrating exterior walls must have internal sealing to prevent condensation from infiltrating humid air.

### 3.03 INSPECTION AND TESTING FOR COMPLETION

- A Notify Owner 7 days prior to beginning completion inspections and tests.
- B Notify authorities having jurisdiction and comply with their requirements for scheduling inspections and tests and for observation by their personnel.
- C Provide the services of the installer's supervisor or person with equivalent qualifications to supervise inspection and testing, correction, and adjustments.
- D Prepare for testing by ensuring that all work is complete and correct; perform preliminary tests as required.
- E Provide all tools, software, and supplies required to accomplish inspection and testing.
- F Upon completion of the installation the Contractor and the Manufacturer's authorized installer together shall conduct a 100% performance test of each and every alarm initiating device for proper response. The system shall operate for 48 hours prior to start of test. The Contractor shall be present for the full 100% test.
- G The A/E and owner must be given 7 days advance notice of the tests. All Audio Visual Device Testing shall be scheduled with the owner.
- H 100% Test: The manufacturer or authorized distributor (by definition, "installer") must 100% test all site-specific software functions for the system and then provide a detailed report or check list showing the system's operational matrix. This documentation must be part of the "System Status and Programming Report".
  - 1. Upon completion of the installation and its programming, the installer's technician shall test every alarm initiating device for proper response and indication, and all alarm notification appliances for effectiveness. Also, in coordination with the other building system contractors, all other system functions shall be verified, including (where applicable) elevator capture and the control of HVAC systems, door locks, pressurization fans, fire or smoke doors/dampers/shutters, etc. The engineer must be notified in advance of these 100% tests, to permit witnessing them if desired.
  - 2. If AHU shutdown occurs for any alarm, then the matrix would indicate the specific control relay(s) for that function being commanded to operate for alarm from any initiating device. If a rolling steel fire door is to drop only upon waterflow alarm from its sprinkler zone, or upon any two spot smoke detectors in adjacent spaces being simultaneously in alarm, the matrix would show the door's control relay activating upon alarm from the applicable waterflow switch(es), or from any two smoke detectors in the selected spaces (AND gate).
  - 3. The digital communicator shall be on-line and tested for proper communication to the receiving station.

4. All supervised circuits must also be tested to verify proper supervision. (Control circuits and remote annunciation lines are among those required to be supervised.)
  5. All testing described above shall be repeated in the event that subsequent software or wiring modifications are determined necessary to meet the requirements of the contract documents. Such re-testing shall be included as part of the base bid and provided at no additional cost to the Owner.
- I Test Documentation: The installer must fill out and submit the following documentation to the owner, through the engineer, prior to the AHJ's system acceptance inspection:
1. Written verification that this 100% system test was done with copy of print out generated during test.
  2. The NFPA 72, "Record of Completion" Form. Use this form (no substitutes) to detail the system installation and also to certify that: (a.) It was done per Code, and (b.) The Code- required 100% test was performed. The fire alarm installer (manufacturer or authorized distributor's technician) must sign this form. If a representative of the AHJ, owner, or engineer witnesses the tests, in whole or in part, they must also sign the form to signify that fact only (annotating the form as needed to clarify their limited role).
  3. For buildings with a smoke control or smoke purge system, an HVAC balance report, in the smoke control / smoke purge mode.
  4. The System Status and Programming Report described in NFPA 72. This must be generated on the day of the system acceptance inspection and shall include the measured sensitivity of each smoke detector.
  5. The purpose of doing Item above on the day of the inspection is to assure detector sensitivity has not been affected by construction dust. Prudent contractors will have taken measures to prevent detector contamination during construction, and will also have had the system do a detector sensitivity test and printout prior to the day of the inspection, to make certain all devices are properly programmed and operating within their limits.
- J After completion of the 100% system test and submission of documentation as described above the installer is to request the engineer to set up an inspection. The system must operate for at least two days prior to this inspection. The responding Fire Department shall be notified of this, for pre-fire planning purposes. On local government projects, local fire authorities may also want to participate in system acceptance inspections. However, for State-owned property they have no inspection jurisdiction and, if present, are only to observe.
- K PRE-FINAL INSPECTION: At the Owner's request and after passing the Designer's pre-final inspection, the Contractor and Manufacturer's authorized installer will conduct system test in the presence of the Owner and the Designer.
- L FINAL INSPECTION: The fire alarm system will be inspected, with portions of it functionally tested. This will normally include the use of appropriate means to simulate smoke for testing detectors, as well as functionally testing the system interface with building controls, fire extinguishing systems and any off-premises supervising station. Operation of any smoke removal system will be checked as instructed by the AHJ. This statistical (sampling) inspection is intended to assure that the contractor has properly installed the system and performed the 100% operational test as required by NFPA 72. The electrical contractor shall provide two-way radios, ladders, and any other materials needed for testing the system, including a suitable smoke source.
1. Smoke control and smoke management systems are normally tested by measuring air flow rates and pressure differentials, plus observing any effect the system has on the operation of exit, elevator, and stairway doors. Testing with smoke "bombs" (smoke candles) is NOT appropriate because they produce cold chemical smoke that lacks buoyancy and, therefore, does not rise like the smoke from a fire.
  2. The test will be conducted entirely by the Contractor. A copy of the final database software must be presented to the Owner before this test. The software shall be loaded from these disks into the system in the presence of the Owner. The review will then be conducted using this software. Any deficiencies shall be recorded and corrected. After the items have been corrected, the system shall be tested again.
    - a. In the event of malfunctions or excessive nuisance alarms, the Contractor must take prompt corrective action. The Owner may require a repeat of the Contractor's 100% system test, or other inspections.

- b. Test Report: Upon successful completion of the Inspection and after the correction of all efficiencies, the manufacturer's authorized representative shall issue a test report to the Engineer and Owner, detailing and certifying the test.
- c. System Acceptance: After successful completion of the Final Inspection and recommendation of the Engineer, the system will be accepted by the Owner. At this time the warranty period begins.

### 3.04 OWNER PERSONNEL INSTRUCTION

- A Provide the following instruction to designated Owner personnel:
  1. Hands-On Instruction: On-site, using operational system.
  2. Classroom Instruction: Owner furnished classroom, on-site or at other local facility.
- B Maintenance Technicians: Detailed training for electrical technicians, on programming, maintaining, repairing, and modifying; factory training:
  1. Initial Training: Minimum of 8 hours of instruction, pre-closeout.
    - a. Training shall cover at a minimum the following:
      - 1) Preventative maintenance service techniques and schedules, including historical data trending of alarm and trouble records.
      - 2) Overall system concepts, capabilities, and functions. Training shall be in depth, so that owner shall be able to take any device out of service and return any device to service without the need of manufacturer's approval or assistance.
      - 3) Explanation of all control functions, including training to program and operate the software.
      - 4) Methods and means of troubleshooting and replacement of all field wired devices.
      - 5) Methods and procedures for trouble shooting the main fire alarm control panel, including field peripheral devices as to programming, bussing systems, internal panel and unit wiring, circuitry, and interconnections.
      - 6) Manuals, drawings, and technical documentation. Actual system software used for training shall be provided in digital form and shall be left with the Owner at the completion of the training for the Owner's use in the future.
- C Furnish the services of instructors and teaching aids; have copies of operation and maintenance data available during instruction.
- D Provide two copies of bound training summary to be referenced by owner's maintenance staff in the future.

### 3.05 CLOSEOUT

- A Closeout Demonstration: Demonstrate proper operation of all functions to Owner.
  1. Be prepared to conduct any of the required tests.
  2. Have at least one copy of operation and maintenance data, preliminary copy of project record drawings, input/output matrix, and operator instruction chart(s) available during demonstration.
  3. Have authorized technical representative of control unit manufacturer present during demonstration.
  4. Demonstration may be combined with inspection and testing required by authority having jurisdiction; notify authority having jurisdiction in time to schedule demonstration.
  5. Repeat demonstration until successful.
- B Occupancy of the project will not occur prior to Project Acceptance.
- C Project Acceptance of the project cannot be achieved until inspection and testing is successful and:
  1. Approved operating and maintenance data has been delivered.
  2. Spare parts, extra materials, and tools have been delivered.
  3. All aspects of operation have been demonstrated to Owner.
  4. Final acceptance of the fire alarm system has been given by authorities having jurisdiction.
  5. Occupancy permit has been granted.
  6. Specified pre-closeout instruction is complete.

### 3.06 MAINTENANCE

- A Perform routine inspection, testing, and preventive maintenance required by NFPA 72, including:
  1. Maintenance of fire safety interface and supervisory devices connected to fire alarm system.
  2. Repairs required, unless due to improper use, accidents, or negligence beyond the control of the maintenance contractor.
  3. Record keeping required by NFPA 72 and authorities having jurisdiction.

- B The manufacturer must maintain software version records on the system installed. The system software shall be upgraded free of charge if a new version is released during the warranty period.
- C Provide trouble call-back service upon notification by Owner:
  - 1. Provide on-site response within 2 hours of notification.
  - 2. Include allowance for call-back service during normal working hours at no extra cost to Owner.
  - 3. Owner will pay for call-back service outside of normal working hours on an hourly basis, based on actual time spent at site and not including travel time; include hourly rate and definition of normal working hours in maintenance contract.
- D Provide a complete description of preventive maintenance, systematic examination, adjustment, cleaning, inspection, and testing, with a detailed schedule.
- E Maintain a log at each fire alarm control unit, listing the date and time of each inspection and call-back visit, the condition of the system, nature of the trouble, correction performed, and parts replaced. Submit duplicate of each log entry to Owner's representative upon completion of site visit.
- F Comply with Owner's requirements for access to facility and security.

**END OF SECTION 28 46 01**