

Addendum No. 3

Austin Masjid
800 N Heatherwilde Blvd., Pflugerville, TX 78660
June 4, 2026



To the Drawings and Specifications dated 4/17/2026, for the Austin Masjid project, 800 North Heatherwilde Boulevard, Pflugerville, Texas 78660, prepared by F S Group Architects, 16575 Village Drive, Houston, Texas 77040, 713-344-1752:



6/4/26

Addendum Date: 6/4/2026

Project Number: 2305

NOTICE TO BIDDERS:

- A. This Addendum shall be considered part of the Bid Documents for the above-mentioned project as though it has been issued at the same time and incorporated integrally therewith. Where provisions of the following supplementary data differ from those of the original Contract Documents, this Addendum shall govern and take precedence.
- B. Bidders are hereby notified that they shall make any necessary adjustments in their estimates on account of this Addendum. It will be construed that each Bidder's proposal is submitted with full knowledge of all modifications and supplemental data specified herein.
- C. Bidders shall acknowledge receipt of this Addendum on the appropriate space on the Bid Form.
- D. The date for receipt of bids is unchanged by this Addendum.

RESPONSES TO BIDDERS' QUESTIONS:

Question 1: *Should we use allowance pricing or HW sets for door hardware?*

Answer 1: *See attached **New Specification 087100** and attached **Revised Sheet A601** for door hardware and hardware sets. These HW sets should be used. You may contact our door hardware supplier for vendor pricing (or choose your own vendor).*

*LaForce Electronic Security Systems, attn: Lawrence Jones, 281-709-4106,
lawrence.jones@laforceinc.com*

Addendum No. 3

Austin Masjid
800 N Heatherwilde Blvd., Pflugerville, TX 78660
June 4, 2026



NEW DOCUMENTS:

The following Documents have been Added and are issued and attached as part of this Addendum:

AM Narrative of Electrical Revisions	Dated 6/3/26
Specification 087100 - Door Hardware	Dated 6/4/26
AM MEP Bid Specs	Dated 6/4/26

REVISIONS TO DOCUMENTS:

The following Documents have been Revised and are issued as part of this Addendum:

NEW DRAWING SHEETS:

The following Drawing Sheet has been Added and is issued and attached as part of this Addendum:

REVISIONS TO DRAWING SHEETS:

The following Sheets have been Revised and are issued and attached as part of this Addendum:

AM Revised Sheet A601	Dated 6/4/26
AM Revised Electrical Sheets E1.01, E1.02, E1.03, E2.00, E2.01, E3.00, E3.01, E3.02, MEP1.01	Dated 6/3/26

End of Addendum No. 3

NARRATIVE OF ELECTRICAL REVISIONS

E1.01

- Added exterior fixture types

E1.02

- Updated panels H1 and L1 on the one-line diagram to have (2) sections.
- Updated wire size on 100AT breakers to have #2 conductors.

E1.03

- Added circuits for receptacles shown on power and lighting floor plan sheets.

E2.00

- Added various power and data outlets to clouded areas for coverage.

E2.01

- Added various power and data outlets to clouded areas for coverage.

E3.00

- Added wall pack lighting.
- Added emergency lighting throughout.
- Added switching and power to chandelier in the ceremonial entry.

E3.01

- Added emergency lighting throughout.
- Added switching to Lobby A207.

E3.02

- Added site photometric calculation sheet.

MEP1.01

- Added telecom line to demark location for fiber and special systems.
- Added notes to use 1"C for power and 2"C for data to each light pole in the parking lot.
- Added site lighting.
- Added plumbing site plan notes.

END OF NARRATIVE FORM

SECTION 087100 - DOOR HARDWARE

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. Mechanical door hardware for the following:
 - a. Swinging wood, steel and aluminum doors.
2. Cylinders for door hardware specified in other Sections.
3. Electrified door hardware.

B. Products furnished, but not installed, under this Section include the products listed below. Coordinating and scheduling the purchase and delivery of these products remain requirements of this Section.

1. Swinging aluminum door hardware.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Details of electrified door hardware.
- C. Samples: As requested.
- D. Schedules shall be kept current with all changes to the project. If changes occur, project hardware schedules shall be maintained to reflect the changes as they are approved. Omitted items shall be deleted from openings, added and replaced items shall be included. Installation submittals shall be kept current as changes occur. Upon request, a complete updated hardware schedule shall be provided to the contractor. Supplemental submittals that include only the changed openings will not be acceptable.
- E. Prior to final payment, provide a record copy of hardware schedules, including all revisions and updates. All openings shall be listed to reflect final installed configuration only.
- F. Other Action Submittals:
 1. Door Hardware Schedule: Prepared by or under the supervision of Installer, detailing fabrication and assembly of door hardware, as well as installation procedures and diagrams. Coordinate final door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
 - a. Format: Use same scheduling sequence and format and use same door numbers as in the Contract Documents.

- b. Content: Include the following information:
 - 1) Identification number, location, hand, fire rating, size, and material of each door and frame.
 - 2) Locations of each door hardware set, cross-referenced to Drawings on floor plans and to door and frame schedule.
 - 3) Complete designations, including name and manufacturer, type, style, function, size, quantity, function, and finish of each door hardware product.
 - 4) Description of electrified door hardware sequences of operation and interfaces with other building control systems.
- 2. Keying Schedule: Prepared by or under the supervision of Installer, detailing Owner's final keying instructions for locks.

1.3 QUALITY ASSURANCE

- A. Supplier Qualifications: The hardware supplier must be a corporate member in good standing of The Door and Hardware Institute (DHI), employing at least one Architectural Hardware Consultant (AHC) who is currently participating in DHI's continuing education program (CEP).
- B. Installer Qualifications: Supplier of products and an employer of workers trained and approved by product manufacturers and an Architectural Hardware Consultant who is available during the course of the Work to consult with Contractor, Architect, and Owner about door hardware and keying.
- C. Source Limitations: Provide electrified door hardware from same manufacturer as mechanical door hardware, unless otherwise indicated. Manufacturers that perform electrical modifications and that are listed by a testing and inspecting agency acceptable to authorities having jurisdiction are acceptable.
- D. Fire-Rated Door Assemblies: Where fire-rated door assemblies are indicated, provide door hardware rated for use in assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C, unless otherwise indicated. Provide positive latching and self closing, regardless if specified in sets.
- E. Smoke- and Draft-Control Door Assemblies: Where smoke- and draft-control door assemblies are required, provide door hardware that meet requirements of assemblies tested according to UL 1784 and installed in compliance with NFPA 105.
 - 1. Air Leakage Rate: Maximum air leakage of **0.3 cfm/sq. ft. (3 cu. m per minute/sq. m)** at the tested pressure differential of **0.3-inch wg (75 Pa)** of water.
- F. Electrified Door Hardware: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.
- G. Means of Egress Doors: Latches do not require more than **15 lbf (67 N)** to release the latch. Locks do not require use of a key, tool, or special knowledge for operation.

- H. Accessibility Requirements: For door hardware on doors in an accessible route, comply with ICC/ANSI A117.1.
 - 1. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than **5 lbf (22.2 N)**.
 - 2. Comply with the following maximum opening-force requirements:
 - a. Interior, Non-Fire-Rated Hinged Doors: **5 lbf (22.2 N)** applied perpendicular to door.
 - b. Sliding or Folding Doors: **5 lbf (22.2 N)** applied parallel to door at latch.
 - c. Fire Doors: Minimum opening force allowable by authorities having jurisdiction.
 - 3. Bevel raised thresholds with a slope of not more than 1:2. Provide thresholds not more than **1/2 inch (13 mm)** high.
 - 4. Adjust door closer sweep periods so that, from an open position of 70 degrees, the door will take at least 3 seconds to move to a point **3 inches (75 mm)** from the latch, measured to the leading edge of the door.
- I. Keying Conference: Conduct conference at Project site to comply with requirements in Section 013100 "Project Management and Coordination."
- J. Items of hardware not definitely specified herein but necessary for completion of the work shall be provided. Such items shall be of type and quality suitable to the service required and comparable to the adjacent hardware. Where size and shape of members is such as to prevent the use of types specified, hardware shall be furnished of suitable types having as nearly as practicable the same operation and quality as the type specified. Sizes shall be adequate for the service required.
- K. Include such nuances as strike type, strike lip length, raised barrel hinges, mounting brackets, blade stop spacers, special templates, fasteners, shims, and coordination between conflicting products. All doors shall be provided with a stop.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver keys to manufacturer of key control system for subsequent delivery to Owner.
- B. Deliver keys and permanent cores to Owner by registered mail or overnight package service.

1.5 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: One year from date of Substantial Completion, unless otherwise indicated.
 - a. Exit Devices: Three years from date of Substantial Completion.
 - b. Manual Closers: Ten years from date of Substantial Completion.

- B. Factory direct order number shall be provided for each shipment of locks, closers and exit devices with warranty, prior to final payment.

PART 2 - PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

- A. Provide door hardware for each door as scheduled in Part 3 "Door Hardware Schedule" Article to comply with requirements in this Section.
 - 1. Door Hardware Sets: Provide quantity, item, size, finish or color indicated, and named manufacturers' products.
 - 2. Sequence of Operation: Provide electrified door hardware function, sequence of operation, and interface with other building control systems indicated.

2.2 HINGES

- A. Hinges: BHMA A156.1. Provide template-produced hinges.
 - 1. Hinge quantity
 - a. Provide 3 hinges per door up to and including 7'5" tall doors.
 - b. Provide 1 additional hinge for each additional 2'6" of door height.
 - 2. Hinge size:
 - a. Provide 4.5" x 4.5" hinges unless otherwise noted.
 - 3. Hinge weight:
 - a. Provide standard weight hinges .134" thick on doors up to and including 36" wide doors.
 - b. Provide heavy weight hinges .180" thick on doors over 36" wide.
 - 4. Hinge base material:
 - a. Exterior butt hinges: Non-ferrous with non-ferrous pin.
 - b. Interior doors: Steel with steel pin.
 - 5. Hinge Options:
 - a. All hinges to be ball bearing.
 - b. Provide non-removable pins (NRP) at all outswinging exterior doors.
 - 6. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Best.
 - b. Hager.
 - c. McKinney

2.3 CONTINUOUS HINGES

- A. Continuous Hinges: BHMA A156.26; minimum ~~0.120-inch-~~ (3.0-mm-) thick, hinge leaves with minimum overall width of 4 inches (102 mm); fabricated to full height of door and frame and to template screw locations; with components finished after milling and drilling are complete.

- B. Continuous, Gear-Type Hinges: Extruded-aluminum, pinless, geared hinge leaves joined by a continuous extruded-aluminum channel cap; with concealed, self-lubricating thrust bearings.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hager Companies.
 - b. Pemko.
 - c. Select Hinges.

2.4 MECHANICAL LOCKS AND LATCHES

- A. Strikes: Provide manufacturer's standard strike for each lock bolt or latchbolt complying with requirements indicated for applicable lock or latch and with strike box and curved lip extended to protect frame; finished to match lock or latch.
 - 1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
 - 2. Extra-Long-Lip Strikes: For locks used on aluminum frames and frames with applied wood casing trim.
 - 3. Aluminum-Frame Strike Box: Manufacturer's special strike box fabricated for aluminum framing.
 - 4. Rabbet Front and Strike: Provide on locksets for rabbeted meeting stiles.
- B. Cylindrical Locks: BHMA A156.2; Series 4000, Grade 1.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Sargent (10X Line)
 - b. No substitutions will be permitted without architect's written approval prior to bidding.

2.5 MANUAL FLUSH BOLTS

- A. Manual Flush Bolts: BHMA A156.2; minimum 3/4-inch (19-mm) throw; designed for mortising into door edge.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hager Companies.
 - b. ABH.
 - c. Rockwood Manufacturing Company.

2.6 AUTOMATIC AND SELF-LATCHING FLUSH BOLTS

- A. Automatic and Self-Latching Flush Bolts: BHMA A156.16; minimum 3/4-inch (19-mm) throw; designed for mortising into door edge.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hager Companies.
 - b. ABH.
 - c. Rockwood Manufacturing Company.

2.7 EXIT DEVICES AND AUXILIARY ITEMS

A. Exit Devices and Auxiliary Items: BHMA A156.3.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Sargent (80 Series).
 - b. No substitutions will be permitted without architect's written approval prior to bidding.

2.8 LOCK CYLINDERS

A. Lock Cylinders: Tumbler type, constructed from brass or bronze, stainless steel, or nickel silver.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Sargent DG1 interchangeable core cylinders with construction core.
 - b. No substitutions will be permitted without architect's written approval prior to bidding.

2.9 KEYING

A. Keying System: Factory registered, complying with guidelines in BHMA A156.28, Appendix A. Incorporate decisions made in keying conference.

1. Master Key System: Key all cylinders to a new master key system. Verify keying requirements with Owner.

B. Keys: Nickel silver.

1. Stamping: Permanently inscribe each key with a visual key control number and include the following notation:
 - a. Notation: "DO NOT DUPLICATE."
2. Quantity: In addition to one extra key blank for each lock, provide the following:
 - a. Cylinder Change Keys: Two.
 - b. Master Keys: Five.
 - c. Core Control Keys: Three
 - d. Construction Master Keys: Ten.

2.10 KEY CONTROL SYSTEM

- A. Key Control Cabinet: BHMA A156.5; metal cabinet with baked-enamel finish; containing key-holding hooks, labels, 2 sets of key tags with self-locking key holders, key-gathering envelopes, and temporary and permanent markers; with key capacity of 150 percent of the number of locks.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Lund Equipment Co., Inc.
 - 2. Wall-Mounted Cabinet: Cabinet with hinged-panel door equipped with key-holding panels and pin-tumbler cylinder door lock.

2.11 OPERATING TRIM

- A. Operating Trim: BHMA A156.6; stainless steel, unless otherwise indicated.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hager Companies.
 - b. Rockwood Manufacturing Company.
 - c. ABH.

2.12 ACCESSORIES FOR PAIRS OF DOORS

- A. Coordinators: BHMA A156.3; consisting of active-leaf, hold-open lever and inactive-leaf release trigger; fabricated from steel with nylon-coated strike plates; with built-in, adjustable safety release; and with internal override.
- B. Carry-Open Bars: BHMA A156.3; prevent the inactive leaf from opening before the active leaf; provide polished brass or bronze carry-open bars with strike plate for inactive leaves of pairs of doors unless automatic or self-latching bolts are used.
- C. Astragals: BHMA A156.22.

2.13 SURFACE CLOSERS.

- A. Surface Closers: BHMA A156.4; rack-and-pinion hydraulic type with adjustable sweep and latch speeds controlled by key-operated valves and forged-steel main arm. Comply with manufacturer's written recommendations for size of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Sargent (351 series).

- b. No substitutions will be permitted without architect's written approval prior to bidding.

2.14 MECHANICAL STOPS AND HOLDERS

- A. Wall- and Floor-Mounted Stops: BHMA A156.16; stainless steel base metal.

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hager Companies.
 - b. Rockwood Manufacturing Company.

2.15 OVERHEAD STOPS AND HOLDERS

- A. Overhead Stops and Holders: BHMA A156.8.

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ABH (Architectural Builders Hardware).
 - b. Norton-Rixson.
 - c. Sargent.

2.16 DOOR GASKETING

- A. Door Gasketing: BHMA A156.22; air leakage not to exceed **0.50 cfm per foot (0.000774 cu. m/s per m)** of crack length for gasketing other than for smoke control, as tested according to ASTM E 283; with resilient or flexible seal strips that are easily replaceable and readily available from stocks maintained by manufacturer.

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hager Companies.
 - b. National Guard Products.
 - c. Pemko.

2.17 THRESHOLDS

- A. Thresholds: BHMA A156.21; fabricated to full width of opening indicated.

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hager Companies.
 - b. National Guard Products.
 - c. Pemko.

2.18 METAL PROTECTIVE TRIM UNITS

- A. Metal Protective Trim Units: BHMA A156.6; fabricated from **0.050-inch- (1.3-mm-)** thick stainless steel; with manufacturer's standard machine or self-tapping screw fasteners.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hager Companies.
 - b. Rockwood Manufacturing Company.

2.19 AUXILIARY DOOR HARDWARE

- A. Auxiliary Hardware: BHMA A156.16.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hager Companies.
 - b. Rockwood Manufacturing Company.
 - c. ABH.

2.20 FABRICATION

- A. Fasteners: Provide door hardware manufactured to comply with published templates prepared for machine, wood, and sheet metal screws. Provide screws that comply with commercially recognized industry standards for application intended, except aluminum fasteners are not permitted. Provide Phillips flat-head screws with finished heads to match surface of door hardware, unless otherwise indicated.
1. Concealed Fasteners: For door hardware units that are exposed when door is closed, except for units already specified with concealed fasteners. Do not use through bolts for installation where bolt head or nut on opposite face is exposed unless it is the only means of securely attaching the door hardware. Where through bolts are used on hollow door and frame construction, provide sleeves for each through bolt.
 2. Fire-Rated Applications:
 - a. Wood or Machine Screws: For the following:
 - 1) Hinges mortised to doors or frames; use threaded-to-the-head wood screws for wood doors and frames.
 - 2) Strike plates to frames.
 - 3) Closers to doors and frames.
 - b. Steel Through Bolts: For the following unless door blocking is provided:
 - 1) Surface hinges to doors.
 - 2) Closers to doors and frames.
 - 3) Surface-mounted exit devices.

3. Spacers or Sex Bolts: For through bolting of hollow-metal doors.
4. Fasteners for Wood Doors: Comply with requirements in DHI WDHS.2, "Recommended Fasteners for Wood Doors."
5. Gasketing Fasteners: Provide noncorrosive fasteners for exterior applications and elsewhere as indicated.

2.21 FINISHES

- A. Provide finishes complying with BHMA A156.18 as indicated in door hardware schedule.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Steel Doors and Frames: For surface applied door hardware, drill and tap doors and frames according to ANSI/SDI A250.6.
- B. Wood Doors: Comply with DHI WDHS.5 "Recommended Hardware Reinforcement Locations for Mineral Core Wood Flush Doors."
- C. Mounting Heights: Mount door hardware units at heights to comply with the following unless otherwise indicated or required to comply with governing regulations.
 1. Standard Steel Doors and Frames: ANSI/SDI A250.8.
 2. Custom Steel Doors and Frames: HMMA 831.
 3. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."
- D. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work. Do not install surface-mounted items until finishes have been completed on substrates involved.
 1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
 2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.
- E. Hinges: Install types and in quantities indicated in door hardware schedule but not fewer than the number recommended by manufacturer for application indicated or one hinge for every **30 inches (750 mm)** of door height, whichever is more stringent, unless other equivalent means of support for door, such as spring hinges or pivots, are provided.
- F. Intermediate Offset Pivots: Where offset pivots are indicated, provide intermediate offset pivots in quantities indicated in door hardware schedule but not fewer than one intermediate offset pivot

per door and one additional intermediate offset pivot for every 30 inches (750 mm) of door height greater than 90 inches (2286 mm).

- G. Key Control System: Tag keys and place them on markers and hooks in key control system cabinet, as determined by final keying schedule.
- H. Boxed Power Supplies: Locate power supplies as indicated or, if not indicated, above accessible ceilings. Verify location with Architect.
 - 1. Configuration: Provide one power supply for each door opening with electrified door hardware.
- I. Thresholds: Set thresholds for exterior doors and other doors indicated in full bed of sealant complying with requirements specified in Section 079200 "Joint Sealants."
- J. Stops: Provide floor stops for doors unless wall or other type stops are indicated in door hardware schedule. Do not mount floor stops where they will impede traffic.
- K. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.
- L. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.
- M. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.
- N. Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

3.2 FIELD QUALITY CONTROL

- A. Independent Architectural Hardware Consultant: Owner will engage a qualified independent Architectural Hardware Consultant to perform inspections and to prepare inspection reports.

3.3 DOOR HARDWARE SCHEDULE

SET 1A

HINGES PER DOOR MANUFACTURER REQUIREMENT

2	EA	SVR EXIT DEVICE	DG1-64-16-NB-8710 x 306	BSP SARGENT
4	EA	CYLINDER CORE	AS REQUIRED	BSP SARGENT
2	EA	OFFSET PULL	MP-HF-RM3311 x 96"	BSP SARGENT
2	EA	CLOSER w/STOP ARM	351 PS	BSP SARGENT
1	EA	THRESHOLD	2716	AL PEMKO
2	EA	SWEEP	315N	BSP PEMKO
1	SET	SEALS	S44	BL PEMKO
1	PR	ASTRAGAL SEALS	S77	BL PEMKO

SET 1B

HINGES PER DOOR MANUFACTURER REQUIREMENT

1	EA	RIM EXIT DEVICE	DG1-64-16-8804 x LESS PULL	BSP SARGENT
2	EA	CYLINDER CORE	AS REQUIRED	BSP SARGENT
1	EA	OFFSET PULL	MP-HF-RM3311 x 84"	BSP SARGENT
1	EA	CLOSER w/STOP ARM	351 PS	BSP SARGENT
1	EA	THRESHOLD	2716	AL PEMKO
1	EA	SWEEP	315N	BSP PEMKO
1	SET	SEALS	S44	BL PEMKO

SET 1C

HINGES PER DOOR MANUFACTURER REQUIREMENT

2	EA	SVR EXIT DEVICE	DG1-64-16-NB-8710 x 306	BSP SARGENT
4	EA	CYLINDER CORE	AS REQUIRED	BSP SARGENT
2	EA	OFFSET PULL	MP-HF-RM3311 x 84"	BSP SARGENT
2	EA	CLOSER w/STOP ARM	351 PS	BSP SARGENT
1	EA	THRESHOLD	2716	AL PEMKO
2	EA	SWEEP	315N	BSP PEMKO
1	SET	SEALS	S44	BL PEMKO
1	PR	ASTRAGAL SEALS	S77	BL PEMKO

SET 2A

8	EA	HINGES		
2	PR	PULLS	RM3301BTB x 48	BSP ROCKWOOD
2	EA	CLOSER w/STOP & HOLD	351 PSH	BSP SARGENT

SET 2B

16	EA	HINGES		
4	PR	PULLS	RM3301BTB x 48	BSP ROCKWOOD
4	EA	CLOSER w/STOP & HOLD	351 PSH	BSP SARGENT

SET 2C

4	EA	HINGES		
1	PR	PULLS	RM3301BTB x 48	BSP ROCKWOOD
1	EA	CLOSER w/HOLD	351 PH10	BSP SARGENT
1	EA	WALL STOP	409	BSP SARGENT

SET 2D

4	EA	HINGES		
1	PR	PULLS	RM3301BTB x 48	BSP ROCKWOOD
1	EA	CLOSER w/STOP & HOLD	351 PSH	BSP SARGENT

SET 2E

8	EA	HINGES		
2	PR	PULLS	RM3301BTB x 48	BSP ROCKWOOD
2	EA	CLOSER	351 O x 351-B	BSP SARGENT
2	EA	OVERHEAD STOP	690S	BSP SARGENT

SET 3A

4	EA	HINGES		
1	EA	PRIVACY LATCH	10XU66 x V30	BSP SARGENT
1	EA	CLOSER	351 UO	BSP SARGENT
1	EA	WALL STOP	409	BSP SARGENT
1	SET	SEALS	S44	BL PEMKO

SET 3B

3	EA	HINGES		
1	EA	PRIVACY LATCH	10XU66 x V30	BSP SARGENT
1	EA	OVERHEAD STOP	690S	BSP SARGENT
1	SET	SEALS	S44	BL PEMKO

SET 3C

4	EA	HINGES		
1	EA	PRIVACY LATCH	10XU66 x V30	BSP SARGENT
1	EA	WALL STOP	409	BSP SARGENT
1	SET	SEALS	S44	BL PEMKO

SET 4A

8	EA	HINGES		
1	EA	OFFICE LOCK	DG1-64-10XG05	BSP SARGENT
1	EA	SURFACE BOLT	580-12	BSP SARGENT
2	EA	WALL STOP	409	BSP SARGENT

SET 4B

4	EA	HINGES		
1	EA	OFFICE LOCK	DG1-64-10XG05	BSP SARGENT
1	EA	CYLINDER CORE	AS REQUIRED	BSP SARGENT
1	EA	CLOSER	351 UO	BSP SARGENT
1	EA	WALL STOP	409	BSP SARGENT

SET 4C

4	EA	HINGES		
1	EA	OFFICE LOCK	DG1-64-10XG05	BSP SARGENT
1	EA	CYLINDER CORE	AS REQUIRED	BSP SARGENT
1	EA	WALL STOP	409	BSP SARGENT

SET 4D

4	EA	HINGES		
1	EA	OFFICE LOCK	DG1-64-10XG05	BSP SARGENT
1	EA	CYLINDER CORE	AS REQUIRED	BSP SARGENT
1	EA	CLOSER w/STOP ARM	351 PS	BSP SARGENT

SET 4E

8	EA	HINGES		
1	EA	OFFICE LOCK	DG1-64-10XG05	BSP SARGENT
1	EA	CYLINDER CORE	AS REQUIRED	BSP SARGENT
1	PR	AUTOMATIC FLUSH BOLTS	2962	BSP ROCKWOOD
1	EA	DUST PROOF STRIKE	570	BSP ROCKWOOD
1	EA	COORDINATOR	2600	BLACK ROCKWOOD
2	EA	CLOSER	351 O x 351-B	BSP SARGENT
2	EA	OVERHEAD STOP	690S	BSP SARGENT
2	EA	FIRE RATED ARMOR PLATE	30" x 2" LDW	BSP ROCKWOOD

SET 4F

4	EA	HINGES		
1	EA	OFFICE LOCK	DG1-64-10XG05	BSP SARGENT
1	EA	CYLINDER CORE	AS REQUIRED	BSP SARGENT
1	EA	CLOSER	351 O x 351-B	BSP SARGENT
1	EA	OVERHEAD STOP	690S	BSP SARGENT
1	EA	FIRE RATED ARMOR PLATE	30" x 2" LDW	BSP ROCKWOOD

SET 4G

4	EA	HINGES		
1	EA	OFFICE LOCK	DG1-64-10XG05	BSP SARGENT
1	EA	CYLINDER CORE	AS REQUIRED	BSP SARGENT
1	EA	OVERHEAD STOP	690S	BSP SARGENT
1	EA	ARMOR PLATE	30" x 2" LDW	BSP ROCKWOOD

SET 4H

4	EA	HINGES		
1	EA	OFFICE LOCK	DG1-64-10XG05	BSP SARGENT
1	EA	CYLINDER CORE	AS REQUIRED	BSP SARGENT
1	EA	OVERHEAD STOP	690S	BSP SARGENT

SET 4J

8	EA	HINGES		
1	EA	OFFICE LOCK	DG1-64-10XG05	BSP SARGENT
1	EA	FLUSH BOLT	555 x 24" TOP ONLY	BSP ROCKWOOD
2	EA	WALL STOP	409	BSP SARGENT

SET 4K

8	EA	HINGES		
1	EA	OFFICE LOCK	DG1-64-10XG05	BSP SARGENT
1	EA	CYLINDER CORE	AS REQUIRED	BSP SARGENT
1	PR	AUTOMATIC FLUSH BOLTS	2962	BSP ROCKWOOD
1	EA	DUST PROOF STRIKE	570	BSP ROCKWOOD
1	EA	COORDINATOR	2600	BLACK ROCKWOOD
2	EA	CLOSER	351 UO	BSP SARGENT
2	EA	WALL STOP	409	BSP SARGENT

SET 5A

4	EA	HINGES		
1	EA	RIM FIRE EXIT DEVICE	12-8815 x ETX	BSP SARGENT
1	EA	CLOSER	351 P10	BSP SARGENT
1	EA	WALL STOP	409	BSP SARGENT

SET 6A

4	EA	HINGES		
1	EA	STOREROOM LOCK	DG1-64-10XG60	BSP SARGENT
1	EA	CYLINDER CORE	AS REQUIRED	BSP SARGENT
1	EA	CLOSER w/STOP ARM	351 PS	BSP SARGENT
1	EA	THRESHOLD	271	AL PEMKO
1	EA	SWEEP	315N	BSP PEMKO
1	SET	SEALS	303PK	BSP PEMKO

SET 6B

4	EA	HINGES		
1	EA	STOREROOM LOCK	DG1-64-10XG60	BSP SARGENT
1	EA	CYLINDER CORE	AS REQUIRED	BSP SARGENT
2	EA	MANUAL FLUSH BOLT	555 (24" TOP BOLT)	BSP SARGENT
1	EA	CLOSER w/STOP & HOLD	351 PHS (ACTIVE LEAF)	BSP SARGENT
1	EA	OVERHEAD HOLDER	690H (INACTIVE LEAF)	BSP SARGENT
2	EA	ARMOR PLATE	30" x 2" LDW	BSP ROCKWOOD
1	EA	THRESHOLD	271	AL PEMKO
2	EA	SWEEP	315N	BSP PEMKO
1	SET	SEALS	303PK	BSP PEMKO
1	EA	ASTRAGAL SEAL	S77	BL PEMKO

SET 6C

4	EA	HINGES		
1	EA	STOREROOM LOCK	DG1-64-10XG60	BSP SARGENT
1	EA	CYLINDER CORE	AS REQUIRED	BSP SARGENT
1	EA	CLOSER	351 UO	BSP SARGENT
1	EA	WALL STOP	409	BSP SARGENT

SET 7A

6	EA	HINGES		
1	EA	STOREROOM LOCK	DG1-64-10XG60	BSP SARGENT
1	EA	SURFACE BOLT	580-12	BSP SARGENT
2	EA	OVERHEAD STOP	690S	BSP SARGENT

SET 8A

4	EA	HINGES		
1	EA	PUSH PLATE	70C	BSP SARGENT
1	EA	PULL	HF-RM3301 x 12"	BSP SARGENT
1	EA	CLOSER	351 UO	BSP SARGENT
1	EA	WALL STOP	409	BSP SARGENT

SET 8B

8	EA	HINGES		
2	EA	PUSH PLATE	70C	BSP SARGENT
2	EA	PULL	HF-RM3301 x 12"	BSP SARGENT
2	EA	CLOSER w/STOP ARM	351 PS	BSP SARGENT

SET 9A

4	EA	HINGES		
1	EA	RIM EXIT DEVICE	DG1-64-8804 x ETX	BSP SARGENT
1	EA	CYLINDER CORE	AS REQUIRED	BSP SARGENT
1	EA	CLOSER w/STOP ARM	351 PS	BSP SARGENT
1	EA	THRESHOLD	271	AL PEMKO
1	EA	SWEEP	315N	BSP PEMKO
1	SET	SEALS	303PK	BSP PEMKO

SET 9B

4	EA	HINGES		
1	EA	RIM EXIT DEVICE	DG1-64-8804 x ETX	BSP SARGENT
1	EA	CYLINDER CORE	AS REQUIRED	BSP SARGENT
1	EA	CLOSER w/STOP ARM	351 PS	BSP SARGENT
1	EA	ARMOR	30" x 2" LDW	BSP ROCKWOOD
1	EA	THRESHOLD	271	AL PEMKO
1	EA	SWEEP	315N	BSP PEMKO
1	SET	SEALS	303PK	BSP PEMKO

SET 10A

1	EA	POCKET DOOR SET	PF28200A6084-XXX x PF134KIT	- PEMKO
1	EA	POCKET DOOR	VTC.2002Q-5.234.XX.134	US19 ACCURATE
		PRIVACY LATCH		
1	EA	EMERGENCY KEY	09-EK	MILL BRASS ACCURATE

SET 10B

1	EA	POCKET DOOR SET	PF28200A6084-XXX x PF134KIT	- PEMKO
1	PR	STRAIGHT PULLS	105BTB	BSP ACCURATE

SET 11A

8	EA	HINGES		
2	EA	ROLLER LATCH	590	BSP ROCKWOOD
1	EA	DEADBOLT	DG1-64-4875	BSP SARGENT
1	EA	CYLINDER CORE	AS REQUIRED	BSP SARGENT
1	EA	FLUSH BOLT	555 x 24" TOP ONLY	BSP ROCKWOOD
2	EA	FLUSH PULL	BF97L	BSP ROCKWOOD
1	EA	WALL STOP	409	BSP SARGENT

SET 11B

8	EA	HINGES		
2	EA	ROLLER LATCH	590	BSP ROCKWOOD
1	EA	DEADBOLT	DG1-64-4875	BSP SARGENT
1	EA	CYLINDER CORE	AS REQUIRED	BSP SARGENT
1	EA	FLUSH BOLT	555 x 24" TOP ONLY	BSP ROCKWOOD
2	EA	FLUSH PULL	BF97L	BSP ROCKWOOD
2	EA	OVERHEAD STOP	690S	BSP SARGENT

SET 12A

8	EA	HINGES		
1	EA	DEADBOLT w/ INDICATOR & TOP & BOTTOM BOLT	MS1850SN-410 x 4089 x 4015 x 4016	335 ADAMS RITE
2	EA	CYLINDER	AS REQUIRED	BSP SARGENT
2	EA	CLOSER w/STOP ARM	351 PSH	BSP SARGENT
1	EA	THRESHOLD	2716	AL PEMKO
2	EA	SWEEP	315N	BSP PEMKO
1	SET	SEALS	S44	BL PEMKO
1	PR	ASTRAGAL SEALS	S77	BL PEMKO

END OF SECTION 087100

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Basic Fire Protection Requirements specifically applicable to Division 21 sections, in addition to Division 01 - General Requirements.

1.02 RELATED DOCUMENTS

- A. Basic and supplemental requirements common to Fire Protection.
- B. THE UNIFORM GENERAL CONDITIONS, SUPPLEMENTARY GENERAL CONDITIONS, and Division 01 of the specifications apply to the work specified in this section.
- C. All work covered by this section of these specifications shall be accomplished in accordance with all applicable provisions of the Contract Documents and any addenda or directives which may be issued herewith, or otherwise.

1.03 GENERAL

- A. The Contractor shall execute all work herein after specified or indicated on accompanying drawings. Contractor shall provide all equipment necessary and usually furnished in connection with such work and systems whether or not mentioned specifically herein or on the Drawings.
- B. The Contractor shall be responsible for fitting his material and apparatus into the building and shall carefully lay out his work at the site to conform to the structural conditions, to avoid all obstructions, to conform to the details of the installation and thereby to provide an integrated satisfactory operating installation
- C. The Fire Protection Drawings are necessarily diagrammatic by their nature, and are not intended to show every connection in detail or every pipe in its exact location. These details are subject to the requirements of standards referenced elsewhere in these specifications, and structural and architectural conditions. The Contractor shall carefully investigate structural and finish conditions and shall coordinate the separate trades in order to avoid interference between the various phases of work. Work shall be organized and laid out so that it will be concealed in furred chases, above suspended ceilings, etc., in finished portions of the building, unless specifically noted to be exposed or where no ceilings exist. All exposed work shall be installed parallel or perpendicular to the lines of the building unless otherwise noted. All work shall be NFPA compliant and compliant with Insurance Underwriter requirements and guidelines.
- D. When the Fire Protection drawings do not give exact details as to the elevation of pipe the Contractor shall physically arrange the systems to fit in the space available at the elevations intended with proper grades for the functioning of the system involved. Piping is generally intended to be installed true and square to the building construction, The Drawings do not show all required offsets, control lines, pilot lines and other location details. Work shall be concealed in all finished areas, unless there is no ceiling.

1.04 DEFINITIONS

- A. These definitions are included to clarify the direction and intention of these Specifications. The list given here is not by any means complete. For further clarification as required, contractor shall contact the designated Owner's representative.
 - 1. Concealed / Exposed: Concealed areas are those that cannot be seen by the building occupants. Exposed areas are all areas that are exposed to view by the building occupants, including under counters, inside cabinets and closets, plus all mechanical rooms.
 - 2. General Requirements: The provisions of requirements of other Division 01 sections apply to entire work of contract and, where so indicated, to other elements that are included in project. Basic contract definitions are included in the General Conditions.

3. Indicated: The term "indicated" is a cross reference to graphic representations, notes or schedules on drawings, to other paragraphs or schedules in the specifications, and to similar means of recording requirements on contract documents. Where terms such as "shown," "noted," "scheduled," and "specified" are used in lieu of "indicated," it is for the purpose of helping reader locate the cross reference, and no limitation of location is intended except as specifically noted.
4. Directed, requested, etc.: Where not otherwise explained, terms such as "directed," "requested," "authorized," "selected," "approved," "required," "accepted," and "permitted" mean "directed by Architect/Engineer," "requested by Architect/Engineer" and similar phrases. However, no such implied meaning will be interpreted to extend Architect's/Engineer's responsibility into Contractor's area of construction supervision and job safety.
5. Approve: Where used in conjunction with Architect's/Engineer's response to submittals, requests, applications, inquiries, reports and claims by Contractor, the meaning of term "approved" will be held to limitations to Architect's/Engineer's responsibilities and duties as specified in General and Supplementary Conditions. In no case will "approval" by Architect/Engineer be interpreted as a release of Contractor from responsibilities to fulfill requirements of contract documents or to extend Architect's/Engineer's responsibility into Contractor's area of construction supervision and job safety.
6. As required: Where "as required" is used in these specifications or on the drawings, it shall mean "that situations exist that are not necessarily described in detail or indicated that may cause the contractor certain complications in performing the work described or indicated. These complications entail the normal coordination activities expected of the Contractor where multiple trades are involved and new or existing construction causes deviations to otherwise simplistic approaches to the work to be performed. The term shall not be interpreted to permit an option on the part of the Contractor to achieve the end result."
7. Furnish: The term "furnish" is used to mean "supply and deliver to project site, ready for unloading, unpacking, assemble, installation, and similar operations. Where "furnish" applies to work for which the installation is not otherwise specified, "furnish" in such case shall mean "furnish and install."
8. Install: The term "install" is used to describe operations at Project Site including the actual "unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.
9. Provide: The term "provide" means "to furnish and install, complete and ready for the intended use.

1.05 REFERENCE STANDARDS

- A. NFPA 13 - Standard for the Installation of Sprinkler Systems; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.06 PERMITS, UTILITY CONNECTIONS AND INSPECTIONS

- A. General: Refer to Division 01 for construction phasing and time increments.
- B. Fees and Costs: If, during the course of the construction, a need arises to buy utilities, the Contractor shall pay all fees attendant thereto. If city or privately owned utility piping or electrical cable needs to be extended, relocated, or terminated, the Contractor will pay all permits and construction/inspection fees associated with that particular work.
- C. All work performed on this project is under the authority of the State of Texas, therefore no local construction fees or construction permits will be required except as may be required for new service taps, or new or modified connections to city controlled services. If inspections by city personnel are specifically required by this document, then the Contractor is responsible for any fees or permits in connection to those requirements.

- D. Compliance: The Contractor shall comply in every respect with all requirements of National Fire Protection Association, local Fire Department regulations and utility company requirements. In no case does this relieve the Contractor of the responsibility of complying with these specifications and drawings where specified conditions are of higher quality than the requirements of the above-specified authorities. Where requirements of the specifications and drawings are more lenient than the requirements of the above authorities having jurisdiction, the Contractor shall make installations in compliance with the requirements of the above authorities with no extra compensation.
- E. Fire hydrant flow test shall be witnessed by a representative of Owner's group.

1.07 CONTRACT DRAWINGS

- A. All dimensional information related to new structures shall be taken from the appropriate drawings. All dimensional information related to existing facilities shall be taken from actual measurements made by the Contractor on the site.
- B. The interrelation of the specifications, the Drawings, and the Schedules are as follows: The Specifications determine the nature and setting of the several materials, the Drawings establish the quantities, dimensions and details, and the Schedules give the performance characteristics. If the Contractor requires additional clarification, he shall request it in writing, following the contractually prescribed information flow requirements.
- C. Should the drawings or specifications conflict within themselves, or with each other, the better quality, or greater size or quantity of work or materials shall be performed or furnished.

1.08 ALLOWANCES

- A. Cash Allowance: Refer to Division 01 of the Construction Documents for information and requirements.

1.09 SUBMITTALS

- A. Refer to Division 01, UGC, and supplemental UGCs for specification requirements pertaining to timeliness of submission and review, quantity, and format. Each specification section describes the content of the submittals and any submittals which must be approved prior to submission of others.
- B. Proposed Products List: Include Products specified in the following sections:
 - 1. Section 21 05 29 – Fire Protection Supports and Sleeves
 - 2. Section 21 05 53 – Fire Protection Piping and Equipment Identification
 - 3. Section 21 08 00 – Fire Protection Systems Commissioning
 - 4. Section 21 10 00 – Water Based Fire Suppression Systems
 - 5. Submit shop drawings and product data grouped to include complete submittals of related systems, products, and accessories clearly marked and/or highlighted, with non-applicable information or data clearly noted in a single submittal.
- C. Mark dimensions and values in units to match those specified.
- D. Submit fabrication drawings whenever (1) equipment proposed varies in physical size and arrangement from that indicated on the Drawings, thus causing rearrangement of equipment space, (2) where tight spaces require extreme coordination between ductwork, piping, conduit, and other equipment, (3) where called for elsewhere in these specifications; and (4) where specifically requested by the Architect/Engineer. Fabrication drawings shall be made at no additional charge to the Owner or the Architect/Engineer.

1.10 SUBSTITUTION OF MATERIALS AND EQUIPMENT

- A. Refer to General Conditions for substitution of materials and equipment.
- B. General: Within thirty days after the date of Contract award or work order, whichever is later, and before purchasing or starting installation of materials or equipment, the Contractor shall

submit for review, a complete list of suppliers, contractors and manufacturers for all materials and equipment that will be submitted for incorporation into the project. The list shall be arranged in accordance with the organization of the specifications. This initial list shall include the manufacturer's name and type or catalog number as required to identify the quality of material or equipment proposed. This list will be reviewed by the Engineer and the Owner and will be returned to the Contractor with comments as to which items are acceptable without further submittal data and which items will require detailed submittal data for further review and subsequent approval. The initial list shall be submitted as herein specified. Materials and equipment requiring detailed submittal data shall be submitted with sufficient data to indicate that all requirements of these specifications have been met and samples shall be furnished when requested. All manufacturers' data used as part of the submittal shall have all inapplicable features crossed out or deleted in a manner that will clearly indicate exactly what is to be furnished.

- C. It is not the intent of the drawings and/or specifications to limit products to any particular manufacturer nor to discriminate against an "APPROVED EQUAL" product as produced by another manufacturer. Some proprietary products are mentioned to set a definite standard for acceptance and to serve as a reference in comparison with other products. When a manufacturer's name appears in these specifications, it is not to be construed that the manufacturer is unconditionally acceptable as a provider of equipment for this project. The successful manufacturer or supplier shall meet all of the provisions of the appropriate specification(s).
- D. The specified products have been used in preparing the drawings and specifications and thus establish minimum qualities with which substitutes must at least equal to be considered acceptable. The burden of proof of equality rests with the Contractor. The decision of the Architect/Engineer is final.
- E. When requested by the Architect/Engineer, the Contractor shall provide a sample of the proposed substitute item. In some cases, samples of both the specified item and the proposed item shall be provided for comparison purposes.
- F. Timeliness: The burden of timeliness in the complete cycle of submittal data, shop drawings, and sample processing is on the Contractor. The Contractor shall allow a minimum of six (6) weeks' time frame for review of each submission by the office of the design discipline involved after receipt of such submissions by that design discipline. The Contractor is responsible for allowing sufficient time in the construction schedule to cover the aforementioned cycles of data processing, including time for all resubmittal cycles on unacceptable materials, equipment, etc. covered by the data submitted. Construction delays and/or lack of timeliness in the above regard are the responsibility of the Contractor and will not be considered in any request for scheduled construction time extensions and/or additional costs to the Owner.
- G. All equipment installed on this project shall have local representation, local factory authorized service, and a local stock of repair parts.
- H. Acceptance of materials and equipment will be based on manufacturer's published data and will be tentative subject to the submission of complete shop drawings indicating compliance with the contract documents and that adequate and acceptable clearances for entry, servicing, and maintenance will exist. Acceptance of materials and equipment under this provision shall not be construed as authorizing any deviations from the specifications, unless the attention of the Architect/Engineer has been directed in writing to the specific deviations. Data submitted shall not contain unrelated information unless all pertinent information is properly identified.
- I. Certification: The Contractor shall carefully examine all data forwarded for approval and shall sign a certificate to the effect that the data has been carefully checked and found to be correct with respect to dimensions and available space and that the equipment complies with all requirements of the specifications.

- J. Physical Size of Equipment: Space is critical; therefore, equipment of larger sizes than shown, even though of specified manufacturer, will not be acceptable unless it can be demonstrated that ample space exists for proper installation, operation, and maintenance.
- K. Materials and Equipment Lists: Eight (8) copies of the list of materials and equipment, the name of manufacturer, trade name, type, and catalog number shall be submitted to the Architect/Engineer. The lists shall be accompanied by eight (8) sets of pictorial and descriptive data derived from the manufacturers' catalogs, sales literature, or incorporated in the shop drawings.
- L. Should a substitution be accepted, and should the substitute material prove defective, or otherwise unsatisfactory for the service intended within the guarantee period, this material or equipment shall be replaced with the material or equipment specified at no additional cost to the Owner.

1.11 MATERIALS AND WORKMANSHIP

- A. All materials, unless otherwise specified, shall be new, free from all defects, suitable for the intended use, and of the best quality of their respective kinds. Materials and equipment shall be installed in accordance with the manufacturer's recommendations and the best standard practice for the type of work involved. All work shall be executed by mechanics skilled in their respective trades, and the installations shall provide a neat, precise appearance. Materials and/or equipment damaged in shipment or otherwise damaged prior to installation shall not be repaired at the job site but shall be replaced with new materials and/or equipment.
- B. The responsibility for the furnishing of the proper equipment and/or material and seeing that it is installed as intended by the manufacturer, rests entirely upon the Contractor who shall request advice and supervisory assistance from the representative of specific manufacturers during the installation.

1.12 FLAME SPREAD PROPERTIES OF MATERIALS

- A. Materials and adhesives incorporated in this project shall conform to NFPA Standard 255, "Method of Test of Surface Burning Characteristics of Building Materials" and NFPA 90. The classification shall not exceed a flame spread rating of 25 for all materials, adhesives, finishes, etc., specified for each system, and shall not exceed a smoke developed rating of 50.

1.13 REGULATORY REQUIREMENTS

- A. The "Authority Having Jurisdiction" over the project described by these documents is the Owner, as an Agency of the State of Texas. As such, it is required that the installation shall meet the minimum standards prescribed in the latest editions of the following listed codes and standards, which are made a part of these specifications. All referenced codes and standards shall be those current at the date of issue of the design documents.
- B. National Fire Protection Association Standards (NFPA)
 - 1. NFPA No. 13, Sprinkler System, Installation, 2013 edition.
 - 2. NFPA No. 70, National Electrical Code, 2017 edition.
 - 3. NFPA No. 72D, Proprietary Signaling Systems, 2013 edition.
 - 4. NFPA No. 101, Life Safety Code, 2015 edition.
 - 5. NFPA No. 291, Recommended Practice for Fire Flow Testing and Marking of Hydrants, current edition.
- C. American National Standards Institute (ANSI)
- D. American Society of Testing Materials (ASTM): All current editions of applicable manuals and standards
- E. American Water Works Association (AWWA): All current editions of applicable manuals and standards.

- F. National Electrical Manufacturers' Association (NEMA): All current editions of applicable manuals and standards.
- G. International Building and Fire Codes, latest edition accepted by the AHJ inclusive of local City and State amendments.
- H. Local Muni Fire Department as may be applicable to construction on this site.
- I. Texas Occupational Safety Act: All applicable safety standards.
- J. Occupational Safety and Health Act (OSHA).
- K. ADA and ANSI Standards: All work shall be in accord with all regulations and requirements of the Standards and Specifications for Handicapped and Disabled for the Construction of Public Buildings and Facilities in the State of Texas Usable by Physically Handicapped and Disabled persons, ANSI Standards and the requirements of the American Disabilities Act.
- L. Refer to Specification sections hereinafter bound for additional Codes and Standards.
- M. All materials and workmanship shall comply with all applicable state and national codes, specifications, and industry standards. In all cases where Underwriters Laboratories, Inc. has established standards for a particular type material, such material shall comply with these standards. Evidence of compliance shall be the UL "label" or "listing" under Re-Examination Service.
- N. The Contract Documents are intended to comply with the aforementioned rules and regulations; however, some discrepancies may occur. Where such discrepancies occur, the Contractor shall immediately notify the Architect/Engineer in writing of said discrepancies and apply for an interpretation. Should the discovery and notification occur after the execution of a contract, any additional work required for compliance with said regulations shall be paid for as covered by Division 01 of these Contract Documents, providing no work of fabrication of materials has been accomplished in a manner of noncompliance. Should the Contractor fabricate and/or install materials and/or workmanship in such a manner that does not comply with the applicable codes, rules and regulations, the Contractor who performed such work shall bear all costs arising in correcting these deficiencies to comply with said rules and regulations

1.14 GENERAL MATERIAL AND EQUIPMENT REQUIREMENTS

- A. Storage at Site: The Contractor shall not receive material or equipment at the job site until there is suitable space provided to properly protect equipment from rust, drip, humidity, and dust damage.
- B. Capacities shall be not less than those indicated but shall be such that no component or system becomes inoperative or is damaged because of startup or other overload conditions.
- C. Conformance with Agency Requirements: Where materials or equipment are specified to be approved, listed, tested, or labeled by the Underwriters Laboratories, Inc., or constructed and/or tested in accordance with the standards of the American Society of Mechanical Engineers or the Air Moving and Conditioning Association, the Contractor shall submit proof that the items furnished under this section of the specifications conform to such requirements. The label of the Underwriters Laboratories, Inc., applied to the item will be acceptable as sufficient evidence that the items conform to such requirements. The ASME stamp or the AMCA label will be acceptable as sufficient evidence that the items conform to the respective requirements.
- D. Nameplates: Each major component of equipment shall have the manufacturer's name, address, and catalog number on a plate securely attached to the item of equipment. All data on nameplates shall be legible at the time of Final Inspection.
- E. Prevention of Rust: Standard factory finish will be acceptable on equipment specified by model number; otherwise, surfaces of ferrous metal shall be given a rust inhibiting coating. The treatment shall withstand 200 hours in salt spray fog test, in accordance with Method 6061 of Federal Standard No. 141. Immediately after completion of the test, the specimen shall show

no signs of wrinkling or cracking and no signs of rust creepage beyond 1/8" on either side of the scratch mark. Where rust inhibitor coating is specified hereinafter, any treatment that will pass the above test is acceptable unless a specific coating is specified except that coal tar or asphalt type coating will not be acceptable unless so stated for a specific item. Where steel is specified to be hot dip galvanized, mill galvanized sheet steel may be used provided all raw edges are painted with a zinc-pigmented paint conforming to Military Specification MIL-P-26915.

- F. Protection from Moving Parts: Belts, pulleys, chains, gears, couplings, projecting set screws, keys, and other rotating parts shall be fully enclosed or properly guarded for personnel protection.
- G. Verification of Dimensions: The Contractor shall be responsible for the coordination and proper relation of his work to the building structure and to the work of all trades. The Contractor shall visit the premises and become thoroughly familiar with all details of the work and working conditions, to verify all dimensions in the field, and to advise the Architect/Engineer of any discrepancy before performing any work. Adjustments to the work required in order to facilitate a coordinated installation shall be made at no additional cost to the Owner or the Architect/Engineer.

1.15 PROJECT/SITE CONDITIONS

- 1. Install Work in locations shown on drawings, unless prevented by Project conditions.
- 2. Prepare drawings showing proposed rearrangement of Work to meet Project conditions, including changes to Work specified in other sections. Obtain permission of Owner before proceeding.

1.16 MANUFACTURER'S RECOMMENDATIONS

- A. The manufacturer's published directions shall be followed in the delivery, storage, protection, installation, testing and piping of all equipment and material. The Contractor shall promptly notify the Architect/Engineer, in writing, of any conflict between the requirements of the Contract Documents and the manufacturer's directions, and shall obtain the Architect/Engineer's instructions before proceeding with the work. Should the Contractor perform any such work that does not comply with the manufacturer's directions or such instructions from the Architect/Engineer, he shall bear all costs arising in connection with the deficiencies.

1.17 SPACE AND EQUIPMENT ARRANGEMENT

- A. The size of Fire Protection equipment indicated on the drawings is based on the dimensions of a particular manufacturer. While other manufacturers may be acceptable, it is the responsibility of the Contractor to determine if the equipment he proposes to furnish will fit in the space. Fabrication drawings shall be prepared when required by the Architect/Engineer or Owner to indicate a suitable arrangement.
- B. All equipment shall be installed in a manner to permit access to all surfaces. All valves, motors, drives, and other accessory items shall be installed in a position to allow removal for service without disassembly of another part.

1.18 LARGE APPARATUS

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

1.19 PROTECTION

- A. The Contractor shall at all times take such precautions as may be necessary to properly protect all materials and equipment from damage from the time of delivery until the completion of the work. This shall include the erection of all required temporary shelters and supports to

adequately protect any items stored in the open on the site from the weather, the ground and surrounding work; the cribbing of any items above the floor of the construction; and the covering of items in the incomplete building with tarpaulins or other protective covering; the installation of electric heaters in electrical switchgear and similar equipment to prevent moisture damage. Failure on the part of the Contractor to comply with the above will be sufficient cause for the rejection of the items in question.

- B. Take particular care not to damage the building structure in performing work. All finished floors, step treads, and finished surfaces shall be covered to prevent any damage by workers or their tools and equipment during the construction of the building.
- C. Equipment and materials shall be protected from rust both before and after installation. Any equipment or materials found in a rusty condition at the time of final inspection must be cleaned of rust and repainted as specified elsewhere in these specifications.

1.20 COOPERATION BETWEEN TRADES AND WITH OTHER CONTRACTORS

- A. Each trade, subcontractor, and/or Contractor must work in harmony with the various other trades, subcontractors and/or Contractors on the job as may be required to facilitate the progress to the best advantage of the job as a whole. Each trade, subcontractor, and/or Contractor must pursue its work promptly and carefully so as not to delay the general progress of the job. This Contractor shall work in harmony with Contractors working under other contracts on the premises.

1.21 ELECTRICAL WIRING OF MOTORS AND EQUIPMENT

- A. The Contractor shall note that the electrical design and Drawings are based on the equipment scheduled and indicated on the Drawings, and should any mechanical equipment be provided requiring changes to the electrical design, the required electrical changes shall be made at no cost to the Owner.
- B. The electrical trades shall provide all interconnecting wiring for the installation of all power. The electrical trades shall provide all disconnect switches as required for proper operation, as indicated on the drawings or required by applicable code. All combination starters, individual starters, and other motor starting apparatus not specifically scheduled or specified as provided by the equipment manufacturer under the scope of Division 23, shall be provided under the scope of Division 21.
- C. Provide complete wiring diagrams indicating power wiring and interlock wiring. Diagrams shall be submitted to the Architect/Engineer for review within thirty (30) days after the submittals for equipment have been reviewed. Diagrams shall be based on accepted equipment and shall be complete full phase and interlock control drawings, not a series of manufacturer's individual diagrams. After these diagrams have been reviewed by the Architect/Engineer, copies shall be transmitted to the electrical trades by the Contractor.

1.22 SUPERVISION

- A. Each Contractor and subcontractor shall keep a competent superintendent or foreman on the job at all times. (Refer to the Uniform General Conditions for additional information concerning supervision.)
- B. It shall be the responsibility of each superintendent to study all drawings and familiarize himself with the work to be done by other trades. He shall coordinate his work with other trades and before material is fabricated or installed, make sure that his work will not cause an interference with another trade. Where interferences are encountered, they shall be resolved at the job site by the superintendents involved. Where interferences cannot be resolved without major changes to the drawings, the matter shall be referred to the A/E for ruling.

1.23 SITE OBSERVATION

- A. Site observation by the Architect/Engineer is for the express purpose of verifying compliance by the Contractor with the Contract Documents, and shall not be construed as construction supervision nor indication of approval of the manner or location in which the work is being performed as being a safe practice or place.

1.24 INSTALLATION METHODS

- A. Where to Conceal: All pipes shall be concealed in pipe chases, walls, furred spaces, or above the ceilings of the building unless otherwise indicated.
- B. Where to Expose: In mechanical rooms, janitor's closets tight against pan soffits in exposed "Tee" structures, or storage spaces, but only where necessary, piping may be run exposed. All exposed piping shall be run in the most aesthetic, inconspicuous manner, and parallel or perpendicular to the building lines.
- C. Support: All piping shall be adequately and properly supported from the building structure by means of hanger rods or clamps to walls as herein specified.
- D. Maintaining Clearance: Where limited space is available above the ceilings below concrete beams or other deep projections, pipe shall be sleeved through the projection where it crosses, rather than hung below them in a manner to provide maximum above floor clearance. Sleeves shall be as herein specified. Approval shall be obtained from the Architect/Engineer for each penetration.
- E. All pipe shall be cut accurately to measurements established at the building and shall be worked into place without springing or forcing. All pipes run exposed in machinery and equipment rooms shall be installed parallel to the building lines, except that piping shall be sloped to obtain the proper pitch. Piping run in furred ceilings, etc., shall be similarly installed, except as otherwise shown. All pipe openings shall be kept closed until the systems are closed with final connections.
 - 1. All piping not directly buried in the ground shall be considered as "interior piping."
 - 2. Prior to the installation of any ceiling material, gypsum, plaster, or acoustical board, the Contractor shall notify the construction inspector so that arrangement can be made for an inspection of the above ceiling area about to be "sealed" off. The Contractor shall give as much advance notice as possible no less than 5 working days or as agreed by the Project Manager.
 - 3. All above ceiling areas will be subject to a formal inspection before ceiling panels are installed, or installation is otherwise concealed from view. All mechanical and electrical work at and above the ceiling, including items supported by the ceiling grid shall be complete and installed in accordance with contract requirements, including power to other powered items. Adequate lighting shall be provided to permit thorough inspection of all above ceiling items. The inspection will include representatives of the following: General Contractor and each Subcontractor having work above the ceiling, Architect/Engineer and Owner's Construction Manager. Areas to be included and time of inspection shall be coordinated with the Construction Inspector.
 - 4. The purpose of this inspection is to verify the completeness and quality of the installation of the air conditioning systems, the electrical systems, the plumbing systems, and any other special above ceiling systems such as pneumatic tube, vacuum systems, fire sprinkler piping and cable tray systems. The ceiling supports (tee bar or lath) shall be in place so that access panel and light fixture locations are identifiable and so that clearances and access provisions may be evaluated.
 - 5. No ceiling materials may be installed until the resulting deficiency list from this inspection is worked off and the Construction Inspector has given approval.

1.25 RECORDS FOR OWNER

- A. The Contractor shall maintain a set of "blueprint" prints in the Field Office for the sole purpose of recording "installed" conditions. Daily note all changes made in these drawings in connection with the final installation including exact dimensioned locations of all new underground utilities, services and systems and all uncovered existing active and inactive piping outside the building.
- B. At contract completion, the Contractor shall provide an electronic file of the revised drawings. The Contractor shall transfer the information from the "blueprint" prints maintained as described above, and turn over this neatly marked set of reproducible drawings representing the "as installed" work to the Architect/Engineer for verification and subsequent transmittal to the Owner. The Contractor shall refer to Division 01 of these Specifications, and to the Uniform General Conditions, for additional information. These Drawings shall include as a minimum:
 - 1. Addendum written Drawing changes.
 - 2. Addendum supplementary Drawings.
 - 3. Accurate, dimensioned locations of all underground utilities, services and systems.
 - 4. Identification of equipment work shown on Alternates as to whether alternates were accepted and work actually installed.
 - 5. Change Order written Drawing changes.
 - 6. Change Order supplementary Drawings.
- C. Electronic Media
 - 1. The Contractor shall submit three (3) compact discs containing all the Drawings in AutoCAD 2017 or 2018 format.
- D. "As installed" plans shall bear a stamp, "stick-on decal" or lettered title block generally located in lower right hand corner of drawing entitled "AS INSTALLED DRAWING" with Company name of the installing trade Subcontractor and with a place for the date and the name of the responsible company representative.
- E. In addition to the above, the Contractor shall accumulate during the progress of the job the following data, in duplicate, prepared in a neat brochure or packet folder and turn over to the Architect/Engineer for review, and subsequent delivery to the Owner.
 - 1. All warranties and guarantees and manufacturers' directions on equipment and material covered by the Contract.
 - 2. Two (2) sets of operating instructions for heating and cooling and other mechanical and electrical systems. Operating instructions shall also include recommended preventative maintenance and seasonal changeover procedures.
 - 3. Valve tag charts and diagrams specified herein.
 - 4. Approved wiring diagrams and control diagrams representing "as installed" conditions.
 - 5. Copies of approved shop drawings.
 - 6. Any and all other data and/or drawings required as submittals during construction.
 - 7. Repair parts list of all major items and equipment including name, address and telephone number of local supplier or agent.
 - 8. All of the above data shall be submitted to the Architect/Engineer for approval, and shall be corrected as instructed by the Architect/Engineer prior to submission of the final request for payment.

1.26 CUTTING AND PATCHING

- A. General: Cut and patch walls, floors, etc., resulting from work in existing construction or by failure to provide proper openings or recesses in new construction.
- B. Methods of cutting: Openings cut through concrete and masonry shall be made with masonry saws and/or core drills and at such locations acceptable to the Architect/Engineer. Impact type equipment shall not be used except where specifically acceptable to the Architect/Engineer. Openings in precast concrete slabs for pipes shall be core drilled to exact size.

- C. Restoration: All openings shall be restored to "as new" condition under the appropriate specification section for the materials involved, and shall match remaining surrounding materials and/or finishes.
- D. Masonry: Where openings are cut through masonry walls, provide and install lintels or other structural supports to protect the remaining masonry. Adequate supports shall be provided during the cutting operation to prevent any damage to the masonry occasioned by the operation. All structural members, supports, etc., shall be of the proper size and shape, and shall be installed in a manner acceptable to the Architect/Engineer.
- E. Plaster: All mechanical work in areas containing plaster shall be completed prior to the application of the finish plaster coat. Cutting of finish plaster coat will not be permitted.
- F. Special Note: No cutting, boring, or excavating that will weaken the structure shall be undertaken.

1.27 ROOF PENETRATIONS AND FLASHING

- A. Pipe, sleeves, pitch pockets, and flashings compatible with the roofing installation shall be provided and installed by a qualified contractor for all roof penetrations. This shall be the responsibility of the General Contractor.

1.28 EXCAVATION, TRENCHING AND BACKFILL

- A. Excavation (See Divisions 00 and 01 for special requirements related to excavation and trenching.):
 - 1. The subcontractors shall perform all excavations of every description, for their particular installations and of whatever substances encountered, to the depths indicated on the drawings and/or required for the installation of piping. All exterior lines shall be installed with a minimum cover of 24," unless otherwise indicated. Generally, more cover shall be provided if grade will permit. All excavation materials not required for backfill or fill shall be removed and wasted as acceptable to the Construction Inspector. All excavations shall be made only by open cut. The banks of trenches shall be kept as nearly vertical as possible and where required, shall be properly sheeted and braced. Trenches shall be not less than 12" wider nor more than 16" wider than the outside edges of the pipe to be laid therein, and shall be excavated true to line so that a clear space not less than 6" nor more than 8" in width is provided on each side of the pipe.
 - 2. The bottom of trenches shall be accurately graded to provide proper fall and uniform bearing and support for each section of the pipe on undisturbed soil or 2" of sand fill at every point along its entire length, except for portions of the pipe sections where it is necessary to excavate for bell holes and for the proper sealing of pipe joints. Bell holes shall be dug after the trench bottom has been graded. Where inverts are not shown, grading shall be determined by the International Fire Code for the service intended and the size used. Bell holes for pipe joints shall be 12" in depth below the trench bottom and shall extend from a point 6" back of the face of the bell. Such bell holes shall be of sufficient width to provide ample room to complete the pipe joint. Bell holes for sewer tile and water pipe shall be excavated only to an extent sufficient to permit accurate work in the making of the joints and to ensure that the pipe, for a maximum of its length, will rest upon the prepared bottom of the trench. Depressions for joints other than bell-and-spigot shall be made in accordance with the recommendations of the joint manufacturer for the particular type of joint used. Special pipe beds shall be provided as specified hereinafter.
 - 3. The lower 4" of the pipe trenches measuring from an overhead line set parallel to the grade line of the sewer shall be excavated only a few feet in advance to the pipe laying, by workers especially skilled in this type of work. Where damage is likely to result from withdrawing sheeting, the sheeting shall be left in place. Except at locations where excavation of rock from the bottom of trenches is required, care shall be taken not to excavate below the depths required. Where rock excavation is required, the rock shall be excavated to a minimum over depth of 6" below the trench depths specified. The over

depth rock excavation and all excess trench excavation shall be backfilled with sand.

Whenever wet or otherwise unstable soil is incapable of properly supporting the pipe is encountered in the trench bottom, such soil shall be removed to a depth and for the trench lengths required, and then backfilled to trench bottom grade, as hereinafter specified, with sand.

4. All grading in the vicinity of excavation shall be controlled to prevent surface ground water from flowing into the excavations. Any water accumulated in the excavations shall be removed by pumping or other acceptable method. During excavation, material suitable for backfilling shall be stacked in an orderly manner a sufficient distance back from edges of trenches to avoid overloading and prevent slides or cave-ins. Material unsuitable for backfilling shall be wasted and removed from the job site as directed by the Construction Inspector.
5. All shoring and sheeting required to perform and protect the excavations and to safeguard employees and/or adjacent structures shall be provided.
6. Excavate as required under the building in order that all piping, etc., shall clear the ground a minimum of 12" for a distance of 24" on either side. Edges of such excavations shall slope at an angle of not over 45 degrees with the horizontal unless otherwise approved by the Construction Inspector. The bottom of such excavation shall be graded to drain in a manner acceptable to the Construction Inspector.
7. Trenches for water lines inside the building shall be properly excavated, following, in general, the procedures set out for exterior lines. Where floors are to be poured over these lines, they shall be backfilled, tamped and settled with water. Where no flooring is to cover the lines, they shall be backfilled to form a level grade.
8. All surplus materials removed in these trenching operations becomes the property of the Contractor, and shall be disposed of at the expense of the Contractor, at a legal disposal site, off of the campus.

B. Backfilling

1. Trenches shall not be backfilled until all required tests are performed and until the piping, utilities systems, etc., as installed are certified by the Owner's inspector to conform to the requirements specified hereinafter. The trenches shall be carefully backfilled with sand to a depth of 12 inches (304.8 mm) above the top of the pipe. The next layer and subsequent layers of backfill may be excavated materials approved for backfilling, consisting of earth, loam, sandy clay, sand and gravel, soft shale, or other approved materials free from large clods of earth or stones larger than 1-1/2" in diameter, flooded until the pipe has cover of not less than one foot. The remainder of the backfill material shall then be thrown into the trenches, moistened, and tamped or flooded in one-foot layers. Blasted rock, broken concrete or pavement, and large boulders shall not be used as backfill material. Any trenches improperly backfilled, or where settlement occurs, shall be reopened to the depth required for proper compaction, then refilled and mounded over, and smoothed off.
2. Backfill under concrete slabs-on-fill shall be as specified above, shall be gravel, or shall be other such materials more suitable for the application. Installation and compaction shall be as required for compatibility with adjacent materials.
3. Opening and Re-closing Pavement and Lawns: Where excavation requires the opening of existing walks, streets, drives, other existing pavement, or lawns, such surfaces shall be cut as required to install new lines and to make new connections to existing lines. The sizes of the cut shall be held to a minimum, consistent with the work to be accomplished. After the installation of the new work is completed and the excavation has been backfilled and flooded, the area shall be patched, using materials to match those cut out. The patches shall thoroughly bond with the original surfaces and shall be level with them, and shall meet all the requirements established by the authorities having jurisdiction over such areas.

4. Excavation in Vicinity of Trees: All trees including low hanging limbs within the immediate area of construction shall be adequately protected to a height of at least 5 feet (152.4 cm) to prevent damage from the construction operations and/or equipment. All excavation within the outermost limb radius of all trees shall be accomplished with extreme care. All roots located within this outermost limb radius shall be brought to the attention of the Construction Inspector before they are cut or damaged in any way. The Construction Inspector will give immediate instructions for the disposition of it. All stumps and roots encountered in the excavation, which are not within the outermost limb radius of existing trees, shall be cut back to a distance of not less than 18" from the outside of any concrete structure or pipeline. No chips, parts of stumps, or loose rock shall be left in the excavation. Where stumps and roots have been cut out of the excavation, clean compacted dry bank sand shall be backfilled and tamped.

1.29 OPERATION PRIOR TO COMPLETION

- A. When any piece of Fire Protection equipment is operable and it is to the advantage of the Contractor to operate the equipment, he may do so, providing that he properly supervises the operation, and has the Project Manager's written permission to do so. The warranty period shall, however, not commence until the equipment is operated for the beneficial use of the Owner, or date of substantial completion, whichever occurs first.
- B. Regardless of whether or not the equipment has or has not been operated, the Contractor shall properly clean the equipment, properly adjust and complete all deficiency list items prior to being started, commissioned and before final acceptance by the Owner. The date of acceptance and performance certification will be the same date.

1.30 CHECKING AND TESTING MATERIALS AND/OR EQUIPMENT

- A. Check inspections shall include fire sprinkler piping, equipment, overall fire protection system controls, and such other items hereinafter specified or specifically designated by the Architect/Engineer.
- B. Contractor shall fill out and submit a "Material and test certificate" in compliance with NFPA 13 – 10.10.0 AND receive fire marshal sign-off prior to 100% payment of underground portion of work.
- C. Contractor shall fill out and submit a "Material and test certificate" per NFPA 13 – 16.1 AND receive fire marshal sign-off prior to payment of 100% for above ground work.
- D. Third party inspections shall be completed prior to final payment.
- E. Contractor shall perform work as required to comply with third party inspections.

1.31 COOPERATION AND CLEANUP

- A. It shall be the responsibility of each trade to cooperate fully with the other trades on the job to help keep the job site in a clean and safe condition. At the end of each day's work, each trade shall properly store all of his tools, equipment and materials and shall clean his debris from the job. Upon the completion of the job, each trade shall immediately remove all of his tools, equipment, any surplus materials and all debris caused by that portion of the work.

1.32 CLEANING AND PAINTING

- A. All equipment and piping, etc., furnished and installed in exposed areas under Division 21 of these specifications and as hereinafter specified shall be cleaned, prepared, and painted according to the following specification. In the event of a conflict between the specifications referenced, the provisions of this specification shall prevail only for Division 21 work.
- B. All purchased equipment shall be delivered to the job with a suitable factory protective finish with the colors hereinafter specified. The following materials shall not be painted: copper, galvanized metal, stainless steel, fiberglass, PVC, and PVDF.

- C. Before painting, materials and equipment surfaces shall be thoroughly cleaned of cement, plaster, and other foreign materials, and all oil and grease spots shall be removed. Such surfaces shall be carefully wiped and all cracks and corners scraped out. Exposed metalwork shall be carefully brushed down with the steel brushes to remove rust and other spots and left smooth and clean.
- D. Color of finish painting shall be painted in accordance with Standard Color Schedule for machinery spaces using Pratt and Lambert, Inc.'s "Effector" enamel, or approved equal. Two (2) coats shall be applied with a light tint first coat and deep color for final coat. Colors shall be as follows:

ITEM	COLOR	"P and L" PAINT NUMBER
Fire Protection Equipment and Piping	Safety Red	R131R (Vibrant Red)

- 1. Note that the paint specified above is included for purposes of establishing a QUALITY THAT shall be used on this Project. The proposed paint shall be submitted, and alternatives will be considered using the submittal procedures specified in this document.
- E. Jacketing on insulation shall not be painted.
- F. No nameplates on equipment shall be painted, and suitable protection shall be afforded to the plates to prevent their being rendered illegible due to the painting operation.
- G. Scope of painting for Division 21 Work in areas other than those defined as "exposed" is as follows:
 - 1. All uncovered steel pipe, supports, exposed pipe and hanger rod threads, and hangers in underfloor spaces shall be cleaned and painted with two (2) coats of Tropical Paint Co. No. 77-black asphaltic emulsion. Galvanized steel and copper lines in these spaces shall not be painted.
 - 2. All canvas finishes including those underfloor and in concealed spaces shall be painted with one sizing coat if not already sized, containing mildew resistant additive and Arabol adhesive prior to any other specified finish paint.
 - 3. All fire protection piping shall be painted whether concealed or exposed, in all areas of the project without exception. Fire protection piping shall be painted safety red. These "safety" colors shall be as defined by OSHA.
 - 4. If insulated, the piping shall be primed, only, prior to insulation, and the insulation jacketing shall be painted as specified for piping. The requirements of this paragraph are "primary" and have priority over any conflicting Specification or instruction, should a conflict in the Construction Documents exist.

PART 2 PRODUCTS

2.01 GENERAL

- A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.
- B. All equipment installed shall have local representation, local factory authorized service, and a local stock of repair parts.
- C. Responsibility for furnishing proper equipment and/or material and ensuring that equipment and/or material is installed as intended by the manufacturer, rests entirely upon the Contractor. Contractor shall request advice and supervisory assistance from the representative of specific manufacturers during the installation.

- D. All materials, unless otherwise specified, shall be new, free from all defects, suitable for the intended use and of the best quality of their respective kinds. Materials and equipment shall be installed in accordance with the manufacturer's recommendations and the best standard practice for the type of Work involved. All Work shall be executed by mechanics skilled in their respective trades, and the installations shall provide a neat, precise appearance. Materials and/or equipment damaged in shipment or otherwise damaged prior to installation shall not be repaired at the job Site but shall be replaced with new materials and/or equipment.
- E. Materials and equipment manufactured domestically are preferred when possible. Materials and equipment that are not available from a domestic manufacturer may be by a non-domestic manufacturer provided they fully comply with Contract Documents.
- F. Prevention of Rust: Standard factory finish will be acceptable on equipment specified by model number; otherwise, surfaces of ferrous metal shall be given a rust inhibiting coating.

2.02 NAMEPLATES

- A. Each major component of equipment shall have the manufacturer's name, address, and catalog number on a plate securely attached to the item of equipment. All data on nameplates shall be legible at the time of Final Inspection.
- B. Nameplates shall be black laminated rigid phenolic with white core. Nameplate minimum size shall be 1 inch (25.4 mm) high by 3 inches (76.2 mm) long with 3/16-inch-high engraved white letters.
- C. Nameplate Fasteners: Fasten nameplates to the front of equipment only by means of stainless steel self-tapping screws. Stick-ons or adhesives will not be allowed unless the NEMA enclosure rating is compromised, then only epoxy adhesive shall be used to attach nameplates.
- D. Nameplate Information: In general, the following information is to be provided for the types of electrical components or enclosures supplied with equipment.
 - 1. Individual Starters, Contactors, Disconnect Switches, and Similar Equipment: Identify the device, and voltage characteristics source and load served.

2.03 WALL, FLOOR AND CEILING PLATES (ESCUTCHEONS)

- A. Except as otherwise noted, provide stainless steel or chrome plated brass floor and ceiling plates around all pipes passing exposed through walls, floors or ceilings, in any spaces except underfloor and plenum spaces.
- B. Plates shall be sized to fit snugly against the outside of the pipe or against the insulation on lines that are insulated and positively secured to such pipe or insulation.
- C. For finished ceiling installation, secure escutcheons to ceiling with escutcheon fasteners.
- D. Plates will not be required for piping where pipe sleeves extend $\frac{3}{4}$ -inch or more above finished floor.

2.04 ROOF PENETRATIONS AND FLASHING

- A. Pipe sleeves, pitch pockets and flashings compatible with the roofing installation shall be provided and installed for all roof penetrations by a contractor qualified in such Work. Installation shall comply with the Contract Documents and with FM General Data Sheets 1-28, 1-29, 1-31 & 1-49 along with the FM approval guide.

PART 3 EXECUTION

3.01 PREPARATION

- A. Cooperate with trades of adjacent, related or affected materials or operations, and with trades performing continuations of this Work in order to effect timely and accurate placing of Work and to coordinate, in proper and correct sequence, the Work of such trades.

- B. The size of equipment indicated on the Drawings is based on the dimensions of a particular manufacturer. While other manufacturers may be acceptable, it is the responsibility of the Contractor to determine that the equipment proposed will fit in the space. Fabrication Drawings shall be prepared when required by the Architect/Engineer or Owner to indicate a suitable arrangement.
- C. All equipment shall be installed in a manner to permit access to all surfaces. All valves, motors, drives, filters, and other accessory items shall be installed in a position to allow removal for service without disassembly of another part.
- D. Space Requirements:
 - 1. Consider space limitations imposed by contiguous Work in location of equipment and material. Do not provide equipment or material which is not suitable in this respect.
 - 2. Make changes in material and equipment locations of up to five (5) feet, to allow for field conditions prior to actual installation, and as directed by the Architect/Engineer at no additional cost to the Owner.
- E. Contractor shall note that the electrical design and Drawings are based on the equipment scheduled and indicated on the Drawings. Should any equipment be provided requiring changes to the electrical design, the required electrical changes shall be made at no cost to the Owner.

3.02 INSTALLATION

- A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.
- B. All installation shall be in accordance with manufacturer's published recommendations, as shown on the drawings and stated in the specifications.
- C. Piping may be run exposed in rooms typically without ceilings such as mechanical rooms, janitor's closets, tight against pan soffits in exposed "tee" structures, or storage spaces, but only where necessary. Shutoff and isolation valves shall be easily accessible.
- D. All pipe, conduits, etc., shall be cut accurately to measurements established at the building and shall be worked into place without springing or forcing. All ducts, pipes and conduits run exposed in machinery and equipment rooms shall be installed parallel to the building lines, except that piping shall be sloped to obtain the proper pitch. Piping and ducts run in furred ceilings, etc., shall be similarly installed, except as otherwise shown. All pipe openings shall be kept closed until the systems are closed with final connections.
- E. Prior to the installation of any ceiling material, gypsum, plaster or acoustical board, the Contractor shall notify Project Manager so that arrangement can be made for an inspection of the above-ceiling area about to be "sealed" off. The Contractor shall provide written notification to the Owner at least five (5) calendar days prior to the inspection.
- F. Precedence of Materials:
 - 1. The Specifications determine the nature and setting of materials and equipment. The Drawings establish quantities, dimensions and details.
 - 2. If interference is encountered, the following installation precedence of materials shall guide the Contractor to determine which trade shall be given the "Right of Way":
 - a. Building lines
 - b. Structural members
 - c. Structural support frames supporting ceiling equipment
 - d. Soil and drain piping
 - e. Vent piping
 - f. Supply, return and outside air ductwork
 - g. Exhaust ductwork
 - h. Condensate piping

- i. Fire protection piping
 - j. Domestic water (cold and hot, softened, treated)
 - k. Refrigerant piping
 - l. Electrical conduit
3. Coordinate fire protection system with other trade systems as required to maintain system right-of-ways.

3.03 TESTING

- A. When any piece of equipment is operable and it is to the advantage of the Contractor to operate the equipment, Contractor may do so, provided that Contractor properly supervises the operation, and has the Project Manager's written permission to do so. The warranty period shall, however, not commence until such time as the equipment is operated for the beneficial use of the Owner, or date of Substantial Completion, whichever occurs first.
- B. Regardless of whether or not the equipment has or has not been operated, the Contractor shall properly clean the equipment, install clean and properly adjust, and complete all deficiency list items before final acceptance by the Owner. The date of acceptance and performance certification will be the same date.
- C. The Contractor shall execute, at no additional cost to the Owner, any tests required by the Owner or the National Fire Protection Association (NFPA), ASTM, etc. standards listed. The Contractor shall provide all equipment, materials and labor for making such tests. The Owner will pay reasonable amounts of fuel and electrical energy costs for system tests. Fuel and electrical energy costs for system adjustment and tests, which follow Substantial Completion by the Owner, will be borne by the Owner.
- D. Notify the Project Manager and the Architect/Engineer in writing at least five (5) calendar days or as agreed by the Project Manager prior to each test and prior to other Specification requirements requiring Owner and Architect/Engineer to observe and/or approve tests.
- E. All tests shall have pertinent data logged by the Contractor at the time of testing. Data shall include date, time, personnel performing, observing and inspecting, description of the test and extent of system tested, test conditions, test results, specified results and other pertinent data. Data shall be delivered to the Architect/Engineer as specified under "Requirements for Final Acceptance." The Contractor or Contractor's authorized job superintendent shall legibly sign all Test Log entries.
- F. Maintain Log of Tests as hereinafter specified.
- G. See Specifications hereinafter for additional tests and requirements.
- H. Refer to Commissioning Specification Sections for additional Start-up, pre-functional and operational checkout, and for functional performance test procedures.

3.04 TRAINING

- A. Operating and Maintenance Manuals and instruction shall be provided as specified under the Division 01 Section entitled "Project Closeout Procedures."
- B. Specific training and operating instructions for individual equipment components shall be as specified in the individual Specification Sections.

END OF SECTION

21 05 29

FIRE PROTECTION HANGERS AND SUPPORTS

PART 1 GENERAL

3.01 REFERENCE STANDARDS

- A. ASME B31.9 - Building Services Piping; 2025.
- B. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.
- C. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications; 2026.
- D. ASTM A780/A780M - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings; 2020.
- E. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength; 2025.
- F. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.
- G. ASTM C1107/C1107M - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink); 2020.
- H. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2025, with Amendment (2026).
- I. MFMA-4 - Metal Framing Standards Publication; 2004.
- J. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2025.
- K. NFPA 13 - Standard for the Installation of Sprinkler Systems; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- L. NFPA 14 - Standard for the Installation of Standpipe and Hose Systems; 2024.

3.02 RELATED DOCUMENTS

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

3.03 SUMMARY

- A. Section Includes:
 - 1. Metal pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Metal framing systems.
 - 4. Fastener systems.
 - 5. Equipment supports.
- B. Related Requirements:
 - 1. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.

3.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
 - 1. Trapeze pipe hangers.
 - 2. Metal framing systems.
 - 3. Equipment supports.

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

3.05 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

3.06 QUALITY ASSURANCE

- A. Structural-Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M.
- B. Pipe Welding Qualifications: Qualify procedures and operators according to 2015 ASME Boiler and Pressure Vessel Code, Section IX.

PART 2 PRODUCTS

4.01 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design trapeze pipe hangers and equipment supports.
- B. Structural Performance: Hangers and supports for fire-suppression piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
 - 1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
 - 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- C. NFPA Compliance: Comply with NFPA 13 and NFPA 14.
- D. UL Compliance: Comply with UL 203.

4.02 METAL PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports:
 - 1. Description: Factory-fabricated components, NFPA approved, UL listed, or FM approved for fire-suppression piping support.
 - 2. Galvanized Metallic Coatings: Pre-galvanized or hot-dip galvanized.
 - 3. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

4.03 TRAPEZE PIPE HANGERS

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

4.04 METAL FRAMING SYSTEMS

- A. MFMA Manufacturer Metal Framing Systems:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. B-line, an Eaton business.
 - b. Flex-Strut Inc.
 - c. Unistrut; Part of Atkore International.
 - 2. Description: Shop- or field-fabricated pipe-support assembly, made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
 - 3. Standard: Comply with MFMA-4, factory-fabricated components for field assembly.
 - 4. Channels: Continuous slotted carbon-steel channel with intumed lips.

5. Channel Width: Selected for applicable load criteria.
6. Channel Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
7. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
8. Metallic Coating: Hot-dip galvanized.

4.05 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Not allowed.
- B. Mechanical-Expansion Anchors: NFPA-approved, UL-listed, or FM-approved, insert-wedge-type anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hilti, Inc.
 - b. ITW Ramset/Red Head; Illinois Tool Works, Inc.
 - c. MKT Fastening, LLC.
 2. Indoor Applications: Zinc-coated or stainless steel.
 3. Outdoor Applications: Stainless steel.

4.06 EQUIPMENT SUPPORTS

- A. Description: NFPA-approved, UL-listed, or FM-approved, welded, shop- or field-fabricated equipment support, made from structural-carbon-steel shapes.

4.07 MATERIALS

- A. Aluminum: ASTM B221.
- B. Carbon Steel: ASTM A1011/A1011M.
- C. Structural Steel: ASTM A36/A36M, carbon-steel plates, shapes, and bars; black and galvanized.
- D. Stainless Steel: ASTM A240/A240M.
- E. Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, non-shrink and nonmetallic grout, suitable for interior and exterior applications.
 1. Properties: Non-staining, non-corrosive, and non-gaseous.
 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 EXECUTION

5.01 APPLICATION

- A. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation, for penetrations through fire-rated walls, ceilings, and assemblies.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

5.02 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with installation requirements of approvals and listings. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size, or install intermediate supports for smaller-diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A36/A36M carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal strut systems.
- D. Fastener System Installation:
 1. Install mechanical-expansion anchors in concrete, after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions. Install in accordance with approvals and listings.
- E. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- F. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- G. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- H. Install lateral bracing with pipe hangers and supports to prevent swaying.
- I. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms, and install reinforcing bars through openings at top of inserts.
- J. Load Distribution: Install hangers and supports, so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- K. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

5.03 EQUIPMENT SUPPORTS

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

5.04 METAL FABRICATIONS

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

5.05 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches (38 mm).

5.06 PAINTING

- A. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded, shop-painted areas on miscellaneous metal are specified in Section 099000 "Painting and Coating."
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A780/A780M.

5.07 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with NFPA requirements for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finishes.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers and metal framing systems and attachments for general service applications.
- F. Use stainless-steel pipe hangers and stainless-steel or corrosion-resistant attachments for hostile environment applications.
- G. Horizontal-Piping Hangers and Supports: Comply with NFPA requirements. Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated, stationary pipes NPS 1/2 to NPS 30.
 - 2. Steel Pipe Clamps (MSS Type 4): For suspension of NPS 1/2 to NPS 24 if little or no insulation is required.
 - 3. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
 - 4. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 8.
 - 5. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 3.
 - 6. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
 - 7. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
 - 8. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
 - 9. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
- H. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
- I. Hanger-Rod Attachments: Comply with NFPA requirements.
 - J. Building Attachments: Comply with NFPA requirements. Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 1. Steel or Malleable-Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. C-Clamps (MSS Type 23): For structural shapes.
 3. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 - K. Comply with NFPA requirements for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
 - L. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
 - M. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 THE FOLLOWING SECTIONS ARE TO BE INCLUDED AS IF WRITTEN HEREIN:

- A. Section 21 00 00 – General Requirements for Fire Suppression.
- B. Section 21 05 29 – Fire Protection Supports and Sleeves.

1.03 SECTION INCLUDES

- A. Nameplates
- B. Tags
- C. Pipe Markers

1.04 REFERENCE STANDARDS

- A. ASME A13.1 - Scheme for the Identification of Piping Systems; 2023.
- B. NFPA 13 - Standard for the Installation of Sprinkler Systems; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.05 RELATED SECTIONS

- A. Section 09 91 00 – Painting: Identification painting.

1.06 REFERENCES

- A. ASME A13.1 – Scheme for the Identification of Piping Systems.
- B. IFC - International Fire Code, 2015 edition.
- C. NFPA 13 - Sprinkler System, Installation, 2013 edition.

1.07 SUBMITTALS

- A. Submit under provisions of Section 21 00 00.
- B. Shop Drawings: Submit list of wording, symbols, letter size, and color coding for fire suppression equipment, piping and valve identification.
 - 1. Equipment Label Schedule: Provide a schedule of all equipment to be labeled with the proposed content for each label.
 - 2. Access Panel and Door Markers: Provide a schedule of all panels and doors to be labeled with the proposed content for each label.
 - 3. Pipe Label Schedule: Provide a schedule of each piping systems indicating a proposed nomenclature and location of all pipe markers.
 - 4. Valve Chart and Schedule: Provide a proposed valve numbering scheme and schedule for each piping system. Tabulate valve number, room or space location, function, valve manufacturer's name and model number, piping system, system abbreviation as shown on tag, normal-operating position (open, closed, or modulating), and variations for identification. Mark valves intended for emergency shut-off and similar special uses.
 - 5. Warning Tags: Provide a schedule of all equipment to be labeled with the proposed content for each label.
- C. Product Data: Provide manufacturers' catalog literature for each product required, including:
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Installation methods.
- D. Samples: Submit two (2) of each type of label, tag, etc., of the approximate size specified of implied in the Specification.

- E. Manufacturer's Installation Instructions: Indicate special procedures, and installation.

1.08 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

1.09 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Section 21 00 00.
- B. Record actual locations of tagged valves and update schedules accordingly.

1.10 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum five (5) years documented experience
- B. Installer Qualifications: Company specializing in performing Work of this section with minimum five (5) years documented experience.
- C. ASME Standards: Comply with ASME A13.1 for color scheme, lettering size, length of color field, and viewing angles of identification devices.

1.11 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging with labels clearly identifying product name and manufacturer until ready for installation.
- B. Storage: Store materials in clean, dry area indoors until ready for installation.
- C. Handling: Protect materials and finish from damage during handling and installation.

PART 2 PRODUCTS

2.01 GENERAL

- A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.
- B. Make it possible for the personnel operating and maintaining the equipment and systems in this project to readily identify the various pieces of equipment, valves, piping, etc., by marking them. All items of equipment such as fire pumps, etc., are to be clearly marked using engraved nameplates as specified. Use equipment identification numbers that appear on the design documents and/or equipment identification numbers furnished by the Owner's Designated Representative.
- C. General: Provide manufacturer's standard products of categories and types required for each application specified. For each identification type, provide all products from same manufacturer with same text, style, color, shape, and other identification features.
 - 1. Provide nameplates with the unit number on all mechanical equipment.
 - 2. Access panel and door markers for standpipes, hose and fire extinguisher cabinets, fire and smoke dampers, etc.
 - 3. Provide pipe identification labels including direction-of-flow arrows and with service indicated. All labels shall have background colors matched with specific service designation.
 - 4. Provide valve tag numbers on all valves.
 - 5. Warning tags at motors and equipment controlled by automatic starters, etc.

2.02 MANUFACTURERS

- A. Equipment Tags, Valve Tags, and Markers:
 - 1. Marking Services, Inc.

2. Seton, owned by Brady Corporation.
3. Brady Corporation
4. Graphic Products, Inc.
5. Brimar Industries.
6. Craftmark.

2.03 EQUIPMENT LABELS

- A. Plastic Labels for Equipment:
 1. Material and Thickness:
 - a. Indoors: Multilayer, multicolor, plastic labels for fire suppression piping and equipment engraving, 1/8 inch (3.18 mm) thick, and having predrilled holes for attachment hardware.
 - b. Outdoors: Chemically resistant plastic with printed graphics protected by a chemical and UV resistant top laminate.
 2. Letter Color: White
 3. Background Color: Red
 4. Maximum Temperature: Able to withstand temperatures up to 160 degrees Fahrenheit (71.11 degrees Celsius).
 5. Minimum Label Size: Length and width vary for required label content, but not less than 1 by 3 inches (76.2 mm).
 6. Minimum Letter Size: 1/4 inch (6.35 mm) for name of units if viewing distance is less than 24 inches (609.6 mm), 1/2 inch (12.7 mm) for viewing distances up to 72 inches (1828.8 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds (2/3) to three-fourths (3/4) the size of principal lettering.
 7. Fasteners: Stainless-steel self-tapping screws.
- B. Label Content: Nomenclature on the label is to include the name of the item, its mark number, area, space, or equipment served, and other pertinent information. Use equipment identification numbers that appear on the design documents and/or equipment identification numbers furnished by the Owner.
- C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.
- D. All scheduled equipment shall be identified with an Equipment Tag.

2.04 ACCESS PANEL AND DOOR MARKERS

- A. Material and Thickness: 1/16-inch- thick, engraved laminated plastic, with abbreviated terms and numbers corresponding to identification.
- B. Letter Color: White
- C. Background Color: Red
- D. Fasteners: Self-tapping, stainless steel screws or contact-type, permanent adhesive.

2.05 VALVE CHART

- A. The Contractor shall prepare and install, in a suitable glazed anodized aluminum frame, typewritten valve charts giving the number, location, function and area or rooms served for each line valve installed under this contract.
- B. Each valve shall be numbered on these charts in accordance with the system of which it is a part of and its location.

2.06 VALVE TAGS

- A. Provide and install identification tags lettered and numbered to correspond to the information shown on the charts described above.
- B. Valve tags shall conform to ANSI A13.1. Valve Tags (Indoors): Stamped or engraved with 1/4 inch (6.35 mm) letters for piping abbreviation and 1/2 inch (12.7 mm) numbers.
 - 1. Tag Material: Brass, 0.032 inch (0.81 mm) minimum thickness, and having predrilled or stamped holes for attachment hardware.
 - 2. Background Color: Natural brass.
 - 3. Letter Color: Black.
 - 4. Tag Size: 1-1/2 inches (38 mm), round.
 - 5. Fasteners: Brass S-Hooks and Jack Chain.
- C. Valve Tags (Outdoors):
 - 1. Material: Chemically resistant plastic with printed graphics protected by a chemical and UV resistant top laminate, and having stainless steel grommet protected predrilled holes with for attachment hardware.
 - 2. Background Color: Red.
 - 3. Letter Color: White.
 - 4. Tag Size: Minimum 1-1/2 inches (38 mm).
 - 5. Fasteners: Stainless steel S-Hooks and stainless steel Jack Chain.

2.07 PIPE LABELS (INDOOR PIPING)

- A. Provide labels for above ground piping located indoors, and not exposed to sunlight or a harsh environment.
- B. Pipe labels shall pre-printed, color-coded, with lettering indicating service, and showing flow direction in conformance with ANSI A13.1 as indicated below.

PIPE CONTENTS	LABEL	LABEL COLORS (BACKGROUND/TEXT)
	ABBREVIATION	
FIRE SUPPRESSION WATER	FIRE	RED/WHITE
WET SPRINKLERS	WET FIRE	RED/WHITE

- C. Lettering shall be sub-surface printed and protected from direct contact by a layer of plastic. Markers with surface printed lettering will not be accepted.
- D. Arrow markers must have same ANSI background colors as their companion pipe markers, or be incorporated into the pipe identification marker.
- E. Plastic Labels for Pipe O.D. less than 8 inches (203.2 mm): Factory fabricated, flexible, semi-rigid plastic, preformed to fit around full circumference pipe or pipe covering and to attach to pipe without fasteners or adhesive in contact with the pipe surface.
- F. Pipe Labels for Pipe O.D. 8 inches (203.2 mm) and Over: Strap-on, semi rigid plastic to cover partial circumference of pipe and to attach to pipe with nylon ties.
- G. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: At least 1-1/2 inches (38 mm) high.
- H. Pipe markers and arrow markers also shall be provided for all piping systems.

2.08 PIPE LABELS (OUTDOOR PIPING)

- A. Provide labels for above ground piping located outside, and exposed to sunlight or a harsh environment, the following product is specified.

- B. Pre-printed, color-coded, with lettering indicating service, and showing flow direction.
- C. Pipe markers shall be constructed of printed 5 mil (0.127 mm) polyester and top laminated with ultraviolet and chemical resistant plastic film that is engineered to provide maximum durability of the printed legend. Markers shall be pre-coiled to wrap entirely around the circumference of pipe up to 10 inch outside diameter, and self-sealed with a strip of clear ultraviolet and chemical resistant plastic film. Coiled markers shall seal to themselves, and not the pipe surface.
- D. Pipe Labels for pipe O.D. up to 10 inches (254 mm): Shall be labeled with a single piece, pre-printed marker that wraps entirely around the circumference of the pipe, overlaps and seals to itself rather than adhere to the pipe surface.
- E. Pipe Labels for pipe O.D. 10 inches and greater: Shall be constructed of printed 5 mil (0.127 mm) polyester and top laminated with clear ultraviolet and chemical resistant plastic film that is pre-applied to an acrylic-faced, co-extruded ABS plastic carrier. Carrier shall have pre-formed legs running the entire length of the part to ensure marker remains straight and aligned with pipe. Flow direction shall be identified by application of a separate arrow label of same construction. Carriers shall be affixed to piping by means of two (2) stainless steel straps that wrap entirely around the circumference of the pipe.
- F. Underground Plastic Pipe markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil (0.1016 mm) thick, manufactured for direct burial service.

2.09 CEILING TACKS

- A. Description: Steel with 3/4 inch (19.05 mm) or 7/8" diameter color coded head.
- B. Color code: Red.

2.10 CEILING GRID TAG FOR EQUIPMENT LOCATED ABOVE LAY-IN CEILING

- A. Description: 3/4" x variable length vinyl label, 3.0 mil (0.0762 mm) self-adhesive vinyl similar to Graphic Products, Inc. DuraLabel Pro™. Label color shall be black text on a white background.
- B. All scheduled equipment above finish lay-in ceiling shall be identified with an Equipment Tag.
- C. All ceiling grid tags shall be installed prior to the ceiling cover inspection.

2.11 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.18 mm) thick, and having predrilled holes for attachment hardware.
- B. Letter Color: White.
- C. Background Color: Red.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (19.05 mm).
- F. Minimum Letter Size: 1/4 inch (6.35 mm) for name of units if viewing distance is less than 24 inches (609.6 mm), 1/2 inch (12.7 mm) for viewing distances up to 72 inches (1828.8 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds (2/3) to three-fourths (3/4) the size of principal lettering.
- G. Fasteners: Stainless-steel self-tapping screws.
- H. Label Content: Include caution and warning information, plus emergency notification instructions.

2.12 WARNING TAGS

- A. Material: Reprinted or partially preprinted, accident-prevention tags; of plasticized card stock with matte finish suitable for writing.
- B. Size: 3 by 5-1/4 inches (133 mm) minimum.

- C. Fasteners: Brass grommet and wire.
- D. Nomenclature: Large-size primary caption such as DANGER, CAUTION, or DO NOT OPERATE.
- E. Color: Yellow background with black lettering.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. Install identifying devices after completion of coverings and painting.
- C. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulates.
- B. For pipe markers that are pre-coiled or strap-on type and do not adhere directly to the piping, no surface preparation is necessary.

3.03 INSTALLATION

- A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.
- B. All installation shall be in accordance with manufacturer's published recommendations.

3.04 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of fire suppression equipment.
- B. Locate equipment labels where accessible and visible.

3.05 ACCESS PANEL AND DOOR MARKERS INSTALLATION

- A. Install or permanently fasten markers on access panels and door for fire suppression equipment.
- B. Locate labels where accessible and visible.

3.06 VALVE TAGS INSTALLATION

- A. Contractor(s) shall provide and install valve tags on all valves installed within this Project, except check valves and valves within factory-fabricated equipment units..
- B. List tagged valves in a valve schedule.

3.07 PIPE LABEL INSTALLATION

- A. Piping runs throughout the Project including those above lift-out ceilings, underfloor and those exposed to view when access doors or access panels are opened shall be identified by means of pipe markers. Concealed areas, for purposes of this identification section, are those areas that cannot be seen except by demolition of the building elements. In addition to pipe markers, arrow markers shall be used to indicate direction of flow.
- B. As a minimum, locate pipe markers as follows:
 - 1. Provide a pipe marker at each valve to indicate proper identification of pipe contents. Where several valves exist on one (1) header, it is necessary to mark only the header.
 - 2. Every 20 feet (609.6 cm) in exposed and concealed areas on all piping systems. Provide at least one (1) pipe marker in each room on all piping systems.
 - 3. At each branch or riser takeoff on piping systems.

4. Provide a pipe marker and an arrow marker at every point of pipe entry or exit where the pipe penetrates a wall, floor, service column or enclosure.
 5. At access doors, manholes and similar access points that permit view of concealed piping.
 6. Near major equipment items and other points of origination and termination.
 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- C. Provide an arrow marker with each pipe marker pointing away from the pipe marker to indicate direction of flow.
 - D. Provide a double-ended arrow marker when flow can be in either or both directions.
 - E. Install plastic tape, and pipe markers completely around pipe in accordance with manufacturer's instructions.
 - F. Locate markers on the two (2) lower quarters of the pipe where view is unobstructed.
 - G. Install underground plastic pipe markers 6 to 8 inches (203.2 mm) below finished grade, directly above buried pipe.

3.08 WARNING TAGS INSTALLATION

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

3.09 CEILING TACKS INSTALLATION

- A. Mark location of equipment or valves located above ceilings with identifying "buttons" to help in identification for maintenance.

3.10 CEILING GRID TAGS INSTALLATION

- A. Provide ceiling grid tags to locate valves or other concealed equipment above T-bar type panel ceilings. Locate in corner of grid closest to equipment.

3.11 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY

- A. This Section includes commissioning process requirements for Fire Protection systems, assemblies, controls, and equipment.
- B. This project will have selected building systems commissioned. The equipment and systems to be commissioned are specified "SECTION 01 91 00 - GENERAL COMMISSIONING REQUIREMENTS".
- C. The scope of commissioning shall include the third party inspections, site verification of entire system, witness and verification of the "material and test certificates"

1.02 RELATED SECTIONS

- A. SECTION 01 91 00 - COMMISSIONING GENERAL REQUIREMENTS
- B. SECTION 22 08 00 – COMMISSIONING OF PLUMBING SYSTEMS
- C. SECTION 23 08 00 – COMMISSIONING OF HVAC SYSTEMS
- D. SECTION 26 08 00 – COMMISSIONING OF ELECTRICAL SYSTEMS
- E. SECTION 28 08 00 – COMMISSIONING OF FIRE ALARM SYSTEMS

1.03 DEFINITIONS

- A. Refer to section 01 91 00 - GENERAL COMMISSIONING REQUIREMENTS

1.04 SUBMITTALS

- A. Certificate of Readiness, signed by the Contractor, certifying that systems, assemblies, equipment, components, and associated controls are ready for testing.
- B. Manufacturer's completed start-up reports for equipment and systems.

1.05 CONTRACTOR'S RESPONSIBILITIES

- A. Reference Project Specification Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for details of contractor's responsibilities related to commissioning.
- B. Perform commissioning tests at the direction of the CxA.
- C. Attend commissioning meetings.
- D. Provide information requested by the CxA for functional testing and for final commissioning documentation.
- E. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.
- F. Functional testing of systems will be carried out solely by contractor's personnel, under the direction of CxA. Provide experienced personnel, familiar with the systems being installed under this project.

1.06 CXA'S RESPONSIBILITIES

- A. Reference Project Specification Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.
- B. CxA will direct commissioning testing. Commissioning provider shall coordinate and provide, licensed, third party inspection prior to final payment. Inspection to include flow test and overhead inspection.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL TESTING REQUIREMENTS

- A. Equipment Testing and Acceptance Procedures: Testing requirements are specified in Division 21 Sections. Provide submittals, test data, inspector record, and certification to the CxA.
- B. Reference Project Specification Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for detailed requirements of commissioning of Mechanical systems.
- C. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.
- D. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.
- E. Tests will be performed using design conditions whenever possible.

3.02 SYSTEM START-UP

- A. Contractor is solely responsible for system start-up. CxA may, at his discretion, witness start up procedures, but will not perform any Functional Testing of systems until Contractor has completed start-up and resolved all operating deficiencies, and has so certified.

3.03 TESTING PREPARATION

- A. Certify that Fire Protection systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.
- B. Certify that testing, adjusting, and balancing procedures for Fire Protection systems have been completed and submitted, discrepancies corrected, and corrective work approved.
- C. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
- D. Inspect and verify the position of each device and interlock identified on checklists.
- E. Check safety cutouts, alarms, and interlocks with life-safety systems during each mode of operation.

3.04 FUNCTIONAL TESTING / GENERAL

- A. Reference Project Specification Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for detailed requirements of commissioning of Plumbing systems.
- B. Provide measuring instruments to record test data as directed by the CxA.

3.05 PIPING SYSTEMS

- A. Pipe system cleaning, flushing, hydrostatic tests, and chemical treatment requirements are specified in Division 22 piping Sections. Plumbing Contractor shall prepare a pipe system cleaning, flushing, and hydrostatic testing plan. Provide cleaning, flushing, testing, and treating plan and final reports to the CxA. Include sequence of testing and testing procedures, description of equipment for flushing operations, drawings for each pipe sector, showing the physical location of each designated pipe test section, minimum flushing water velocity, and chemical treatment plan.

3.06 DEFERRED TESTING

- A. Initial commissioning will be done as soon as contract work is completed, though building may not be at full occupancy and equipment may not be at full loading.

- B. If adequate load may be artificially placed upon heating or cooling equipment, CxA, at his discretion, may perform functional testing during non-peak load periods. If testing cannot be carried out under these conditions to adequately verify system performance, testing will be deferred until such time as conditions are more satisfactory.
 - 1. Contractor is to provide services of personnel and participate in deferred or seasonal testing process in the same manner as he would in non-seasonal testing.
 - 2. If tests cannot be completed because of a deficiency outside the scope of the Plumbing system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.

3.07 RE-TESTING

- A. Reference Project Specification Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for detailed requirements of re-testing of Plumbing systems.

3.08 SYSTEMS TO BE COMMISSIONED

- A. Reference Project Specification Section 01 91 00 COMMISSIONING GENERAL REQUIREMENTS for list of Fire Protection systems to be commissioned.

END OF SECTION

PART 1 GENERAL

1.01 SCOPE

- A. The Contractor shall provide all components required for the complete installation of automatic sprinkler systems as hereinafter specified and indicated on the Drawings.
- B. System Layout: The fire sprinkler areas, piping, head locations, etc. as indicated is only for Contractor's reference as to areas to be protected and possible piping routes. If header or manifold sizes are given in the drawings, then the sizes given shall be the minimum sizes installed. Actual number, spacing and location of heads, size and routes of piping shall be provided in accordance with the applicable Specifications and acceptable Shop Drawings. All layouts, head spacing, coverage, etc., as may be required by the referenced authorities and/or Architectural and Structural conditions shall be made without increase in cost to the Owner or the Architect/Engineer. Modifications to head spacing, pipe routes, etc. shall be closely coordinated with the work of all other trades. The Fire Sprinkler Subcontractor shall be responsible for the design and installation of the fire sprinkler system as described herein and on the project drawings. The piping of the system shall be sized using the "hydraulic" method, as included in NFPA Standard No. 13. Piping sized using the "schedule" method is unacceptable.

1.02 THE FOLLOWING SECTIONS ARE TO BE INCLUDED AS IF WRITTEN HEREIN:

- A. Section 21 00 00 – General Requirements for Fire Suppression
- B. Section 21 05 29 – Fire Protection Supports and Sleeves
- C. Section 21 05 53 – Fire Protection Piping and Equipment Identification

1.03 SECTION INCLUDES

- A. Pipe, fittings, valves, and connections for sprinkler system.

1.04 REFERENCE STANDARDS

- A. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250; 2026.
- B. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; 2021.
- C. ASME B16.4 - Gray Iron Threaded Fittings: Classes 125 and 250; 2021.
- D. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24 Metric/Inch Standard; 2025.
- E. ASME B16.9 - Factory-Made Wrought Buttwelding Fittings; 2024.
- F. ASME B16.11 - Forged Fittings, Socket-Welding and Threaded; 2021.
- G. ASME B16.25 - Buttwelding Ends; 2022.
- H. ASME B36.10 - Welded and Seamless Wrought Steel Pipe; 2022.
- I. ASME BPVC - Boiler and Pressure Vessel Code; 2025.
- J. ASTM A536 - Standard Specification for Ductile Iron Castings; 2024.
- K. ASTM B32 - Standard Specification for Solder Metal; 2020.
- L. MSS SP-25 - Standard Marking System for Valves, Fittings, Flanges and Unions; 2018, with Errata (2023).
- M. MSS SP-67 - Butterfly Valves; 2022.
- N. MSS SP-80 - Bronze Gate, Globe, Angle, and Check Valves; 2019.
- O. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; 2010, with Errata .

- P. NFPA 13 - Standard for the Installation of Sprinkler Systems; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- Q. NFPA 24 - Standard for the Installation of Private Fire Service Mains and Their Appurtenances; 2025.

1.05 RELATED SECTIONS

- A. Section 31 23 16.13 – Trenching
- B. Section 09 91 00 - Painting

1.06 REFERENCES

- A. ANSI/ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800.
- B. ANSI/ASME B16.3 - Malleable Iron Threaded Fittings, Class 150 and 300.
- C. ANSI/ASME B16.4 - Cast Iron Threaded Fittings, Class 125 and 250.
- D. ANSI/ASME B16.5 - Pipe Flanges and Flanged Fittings.
- E. ANSI/ASME B16.9 - Factory-made Wrought Steel Buttwelding Fittings.
- F. ANSI/ASME B16.11 - Forged Steel Fittings, Socket-welding and Threaded.
- G. ANSI/ASME B16.25 - Buttwelding Ends.
- H. ANSI/ASME B36.10 - Welded and Seamless Wrought Steel Pipe.
- I. ANSI/ASME Boiler and Pressure Vessel Code (BPVC), Sec IX - Welding and Brazing Qualifications.
- J. ANSI/ASTM A135 - Electric-Resistance-Welded Steel Pipe.
- K. ANSI/ASTM A47 - Malleable Iron Castings.
- L. ANSI/ASTM B32 - Solder Metal.
- M. ANSI/AWS A5.8 - Brazing Filler Metal.
- N. ANSI/AWWA C110 - Ductile Iron and Gray Iron Fittings.
- O. ANSI/AWWA C151 - Ductile Iron Pipe, Centrifugally Cast.
- P. ASTM A53 - Pipe, Steel, Black and Hot-Dipped, Zinc-coated Welded and Seamless.
- Q. ASTM A120 - Pipe, Steel, Black and Hot-Dipped, Zinc-coated (Galvanized) Welded and Seamless, for Ordinary Uses.
- R. ASTM A234 - Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
- S. ASTM A795 - Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use.
- T. AWS D10.9 - Specifications for Qualification of Welding Procedures and Welders for Piping and Tubing.
- U. IFC - International Fire Code, latest edition accepted by AHJ with local municipality amendments.
- V. NFPA 13 - Installation of Sprinkler Systems, 2013 edition.
- W. NFPA 24 - Installation of Private Fire Service Mains and Their Appurtenances
- X. NFPA 51B - Standard for Fire Prevention During Welding, Cutting, and Other Hot Work.

- Y. UL - Fire Protection Equipment Directory.
- Z. Local Municipality Fire Department Standards.
- AA. State of Texas, State Fire Marshal Rules.
- BB. All hose threads, coupling types, etc., utilized in the fire protection systems shall conform to the standards and requirements of the local municipality Fire Department.

1.07 SUBMITTALS

- A. Submit under provisions of Section 21 00 00.
- B. Shop Drawings:
 - 1. Prior to detailed submission, submit preliminary layout showing head locations within coordinated ceiling grid and inspector's test station locations for review by Architect/Engineer.
 - 2. Submit shop drawings and obtain approval from all authorities prior to material purchasing, fabrication of any piping or installation of any components of the fire protection systems. Include detailed plans showing all piping, elevations of piping above finished floors, pipe sizes, hangers, supports, sprinkler heads, valves, siamese connections, concrete thrust block details, inspector's test locations, system drains, etc. Indicate pipe materials used, jointing methods, supports, floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.
 - 3. Hydraulic calculations: Submit flow test results and comprehensive hydraulic data sheets complying with NFPA 13. Verification of the adequacy of water pressure and other pertinent water supply data shall be the responsibility of the design engineer.
 - 4. Sprinkler heads shall be shown on Drawings and specifically identified by the style or series designation as published in the appropriate agency listing or approval.
 - 5. Design systems under direct supervision of a Professional Engineer experienced in design of this work and licensed in the State of Texas. All design submittal documents and shop drawings, including drawings and hydraulic calculations, shall bear the Responsible Engineer's signed and dated seal. Include all costs for obtaining approval from a Professional Engineer licensed in the State of Texas.
- C. Product Data: Provide data on pipe materials, pipe fittings, sprinkler heads, valves, fire hose cabinets, flow switches, tamper switches, all other components and accessories. , Include manufacturer's catalogue information, code and standards compliance, performance ratings rough-in details, weights, support requirements, and piping connections.
- D. Samples: Submit one (1) of each style of sprinkler head specified.
- E. Manufacturer's Certificate: Certify that system has been tested and meets or exceeds requirements specified, and suggested by listed codes.
- F. Certification of Installation: Provide a letter of certification stating that the installed and tested fire protection systems comply with the requirements of NFPA. The certification letter is to be authored, sealed, dated and signed by a licensed Fire Protection Engineer experienced in design and installation of this work and licensed in the state of Texas. Include all costs for obtaining approval from the licensed Fire Protection Engineer.
- G. Provide certificate of compliance from authority have jurisdiction indicating approval of field acceptance tests.
- H. Project Record Documents
 - 1. Submit under provisions of Section 21 00 00.
 - 2. Record actual locations of sprinkler heads and deviations of piping from drawings. Indicate drain and test locations.

1.08 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Section 21 00 00.
- B. Maintenance Instructions: Include installation instructions, spare parts lists, procedures, and treatment programs.

1.09 QUALITY ASSURANCE

- A. Sprinkler Systems: Perform work to NFPA 13.
- B. Welding Materials and Procedures: Perform to ASME BPVC, Section IX.
- C. Equipment and Components: Bear FM label or marking. Provide manufacturer's name and pressure rating marked on valve body.
- D. Maintain one (1) copy of each document on site.
- E. Qualifications of the Installer: The system shall be installed by a firm regularly engaged in the design and installation of automatic sprinkler systems in accordance with requirements of the National Fire Protection Association and Fire Protection and the Texas Department of Insurance Fire Sprinkler Rules, or by an authorized agent of such firm. Evidence to support the above requirements may be required and any proposed installer who cannot show suitable experience will be rejected.
- F. Design system under direct supervision of a Professional Engineer experienced in design of this work and licensed in the State of Texas. All design submittal documents and shop drawings shall bear the Responsible Engineer's signed and dated seal.
- G. All parts of fire protection piping systems shall conform to all provisions of Underwriters' Laboratories requirements. All equipment shall bear the Underwriters' Laboratories label of approval.
- H. Determine volume and pressure of incoming water supply from residual pressure water flow test.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. All materials shall be new, undamaged, and free of rust.
- B. Deliver, store, protect, and handle products to site under provisions of Section 21 00 00.
- C. Deliver and store valves in shipping containers with labeling in place.
- D. Inspect shipments for possible damage during transit. Do not use damaged materials in any part of the system.
- E. Provide temporary protective coating on cast iron and steel valves. fittings and valves not packaged within containers. Maintain in place until installation.
- F. Protect all materials that are to be installed within this Project from exposure to rain, freezing temperatures and direct sunlight. EXCEPTION: Materials manufactured for exterior locations.
- G. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

1.11 EXTRA MATERIALS

- A. Furnish under provisions of Section 21 00 00.
- B. The Contractor shall provide spare heads equal to one percent (1%) of the total number of heads installed under the Contract, but not less than ten (10).
- C. The heads shall be packed in a suitable wall mounted metal storage cabinet and shall be representative of, and in proportion to, the number of each type and temperature rating heads installed. The cabinet shall be located where directed by the Construction Inspector.

- D. In addition to the spare heads, the Contractor shall provide not less than one (1) special sprinkler head wrench for each type of head.

1.12 WARRANTY

- A. The complete system shall be warranted in writing against defects in materials or Workmanship under normal use and service for a period of one (1) year after date of Substantial Completion.

PART 2 PRODUCTS

2.01 GENERAL

- A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.
- B. All piping, materials and equipment used in the installation of sprinkler system shall be new and listed as approved by the Underwriters' Laboratories, Inc., List of Inspected Fire Protection Equipment and Materials and the Factory Mutual Testing Laboratories List of Approved Equipment, Fire Protection Devices and Devices Involving Fire Hazard and shall be the latest design of the manufacturer.
- C. Pressure ratings of pipe, fittings, valves, gauges and all other water carrying appurtenances shall be suitable for the anticipated system pressures in which they are installed.
- D. The installing Contractor shall identify piping, fire department connections, valves and hydraulic design information in accordance with applicable NFPA Standards.

2.02 UNIONS

- A. Provide and install unions at proper points to permit removal of pipe and various equipment and machinery items without injury to other parts of the system. No unions will be required in welded lines. Unions 2 inch (50.8 mm) and smaller shall be Class 300 AAR threaded malleable iron unions with iron to brass seats, and 2-1/2 inch (64 mm) and larger shall be ground flange unions. Companion flanges on lines at various items for equipment machines and pieces of apparatus shall serve as unions to permit removal of the particular items.

2.03 FLANGES

- A. All 150 lb. and 300 lb. ANSI flanges shall be weld neck and shall be domestically manufactured, forged carbon steel, conforming to ANSI B16.5 and ASTM A181 Grade I or II or A105-71 as made by Tube Turns or Hackney-Ladish Company. Slip on flanges shall not be used. Each fitting shall be stamped as specified by ANSI B16.9 and, in addition, shall have the laboratory control number stenciled on each fitting for ready reference as to physical properties and chemical composition of the material. Complete test reports may be required for any fitting selected at random.
- B. Flanges which have been machined, remarked, painted or otherwise produced domestically from imported forges will not be acceptable. Flanges shall have the manufacturer's trademark permanently identified in accordance with MSS SP-25. Contractor shall submit data for firm certifying compliance with these Specifications.
- C. Bolts used shall be carbon steel bolts with semi-finished hexagon nuts of American Standard Heavy dimensions. All thread rods will not be an acceptable for flange bolts.
- D. Flat faced flanges shall be furnished to match 125 lb cast iron flanges on pumps, check valves, strainers, etc. with full flange gaskets. Bolting of raised face flanges to flat faced flanges is not allowed.

2.04 FLANGE GASKETS

- A. Gaskets shall be placed between the flanges of all flanged joints.

- B. Gaskets shall be ring form gaskets fitting within the bolt circle of their respective flanges. Gaskets shall be 1/16" thick asbestos free material recommended for service by Anchor Seals, Garlock, or John Crane. The inside diameter of such gaskets shall conform to the nominal pipe size and the outside diameter shall be such that the gasket extends outward to the studs or bolts employed in the flanged joint.
- C. Spares: Contractor shall provide ten (10) spare gaskets for every flange size and rating.

2.05 WALL, FLOOR AND CEILING PLATES

- A. See Section 21 00 00.

2.06 SLEEVES, INSERTS, AND FASTENINGS

- A. General: All openings through all floors, walls, and roofs, etc., regardless of material for the passage of piping, etc., shall be sleeved. Refer to Specification Section 21 05 29.

2.07 UNDERGROUND FIRE PROTECTION PIPING

- A. Acceptable Manufacturers: Pipe and joints shall be as manufactured in the United States by American Cast Iron Pipe Company, Tyler Pipe (a Division of McWane), U.S. Pipe Company, McWane Cast Iron Pipe Company, or Engineer accepted equivalent.
- B. Pipe
 - 1. ANSI A21.50 (AWWA C150) and ANSI A21.51 (AWWA C151) cement mortar lined ductile iron, supplied in 16 feet (487.68 cm) laying lengths.
 - 2. Thickness
 - a. Piping 4" and Smaller: Class 51.
 - b. Piping 6" and Larger: Class 50.
- C. Fittings
 - 1. Class 250 AWWA C110, cement mortar lined, ductile or gray iron, standard thickness.
 - 2. Tappings in ductile iron pipe shall be made with dual compression seal tapping sleeve, similar and Architect/Engineer accepted equivalent to U.S. Pipe Model T-28.
 - 3. Joints
 - 4. Ductile Iron Pipe to Ductile Iron Pipe: Unless noted otherwise on the Drawings, all joints shall be restrained mechanical joints.
 - 5. Ductile Iron Pipe to Steel Iron Pipe: ANSI/AWWA C110 flanged fittings adequate for 250 psi (1723.69 kPa) working pressure. Provide with dielectric flange insulating kit with insulating sleeves and washers for each bolt.
 - 6. Pipe to Valve: ANSI/AWWA C110 flanged fittings adequate for 250 psi (1723.69 kPa) working pressure.
 - 7. Bolts: High strength, Type 316 stainless steel tee head bolts with hexagon nuts.
 - 8. Gaskets: ANSI A21.11 / AWWA C111 ethylene propylene diene monomer (EPDM) suitable for 220°F.
- D. Coating: Pipe and fittings shall be cement mortar lined. Coat pipe and fittings outside with the manufacturer's standard asphaltic sealcoat in accordance with the latest revision of ANSI Standard A21.4 (AWWA C104) suitable for domestic water service.
- E. Casing: Unless otherwise noted on the Drawings, all ductile iron pipe, fittings, etc., shall be encased in 8 mils (0.2032 mm) thick polyethylene tubing in accordance with the latest revision of ANSI Standard A21.5 (AWWA C105).
- F. Ductile iron piping, fittings, and joints shall be suitable for the minimum working pressure and sizes indicated on the Drawings, in Type 4 laying conditions with 2 to 15 feet (457.2 cm) of cover, and as required for freeze protection, unless otherwise indicated on the Drawings.

2.08 ABOVE GROUND FIRE PROTECTION PIPING

- A. All pipe used for fire protection fire sprinkler systems shall be Schedule 40 black steel pipe conforming to ASTM A795 or ASTM A53. All piping 2-1/2" and larger shall be welded, unless otherwise indicated herein.
- B. Use of mechanically coupled grooved piping, when approved by Engineer, shall be "roll" grooved type; cut grooved pipe is not permitted.
- C. Schedule 10 and "thin wall" fire sprinkler pipe is not permitted.
- D. Fittings:
 - 1. Piping 2" and Smaller: Class 150 malleable iron threaded fittings conforming to ASME B16.3.
 - 2. Piping 2-1/2" and Larger: Welding type steel fittings conforming to ASTM A234 and ANSI B16.9. In lieu of welding type fittings, grooved type fittings may be used on sprinkler systems. Pipe size changes shall be performed through the use of reducing tees or reducers designed for that purpose. The use of bushings is explicitly prohibited.
 - 3. Grooved end couplings 2-1/2" and larger shall be Victaulic Style 07 "Zero-Flex" Rigid Coupling, with EPDM gasket (minimum 700 psi (4826.33 kPa) working pressure) for use with roll grooved piping. Products by Victaulic and Anvil are acceptable, or Engineer-approved equal. Reducing type couplings, outlet couplings, "T" outlet fittings, cut-in style fittings, snap joint couplings, and flange adapter type fittings are not acceptable. Provide grooved fittings similar to standard weld fittings.
 - 4. Extra heavy "Thread-o-lets" shall be used at each point of departure from the riser to the fire hose or valve cabinet. A "Thread-o-let" shall be installed below the level of the valve in the cabinet and a minimum of two (2) threaded ells shall be used to provide a swing joint connection from the riser to the valve in the cabinet.

2.09 VALVES

- A. General:
 - 1. All shutoff valves shall be UL listed and FM approved for fire protection service.
 - 2. Similar types of valves shall be the product of one manufacturer; i.e., all butterfly valves shall be of the same manufacture, all ball valves shall be of the same manufacture, etc.
 - 3. All valves used to control the flow of water to and within sprinkler systems shall be listed indicating type complete with electric supervisory switches. Coordinate wiring with the Electrical Contractor.
- B. Shutoff valves for sizes 2 inch (50.8 mm) and smaller:
 - 1. Two (2) piece bronze ball valve, bubble-tight shutoff, full port, blow-out proof stem, chrome plated brass ball and silicon bronze stem, threaded end connections, conforming to MSS SP-110.
 - 2. One (1) piece, butterfly valve, full port, threaded ends, bronze housing and body, stainless steel disc. EPDM disc seal and slow closing.
 - 3. All valves shall be furnished with two (2) factory mounted internal supervisory switches.
- C. Shut off valves for sizes over 2 inch (50.8 mm):
 - 1. Butterfly valves lug type with EPDM molded in seat liner, ductile iron disc, stainless steel stem, manual gear operator, conforms to MSS SP-67 and MSS SP-25, with integral supervisory switch. Where a grooved piping system is allowed, grooved end type butterfly valves may be used, consisting of ductile iron body and disc EPDM seats, stainless steel stem. Valves shall be equipped with internal supervisory switch.
 - 2. Gate valves – OS&Y (Outside Yoke and Stem) resilient wedge, epoxy coated interior and exterior, ASTM A536 ductile iron valve body, bonnet and resilient wedge, ASTM B150 stem and flanged ends.
- D. Check valves for sizes 2 inch (50.8 mm) and smaller:

1. Horizontal swing, bronze body, conforming to MSS SP-80, threaded ends and rubber disc.
- E. Check valves for sizes over 2 inch (50.8 mm):
 1. Iron body swing-check, bronze disc, seat ring and hinge pin, UL listed and FM approved, flanged ends, renewable seats and disc, tapped 3/4 inch (19.05 mm) for ball drip assembly.

F. Standard of Quality for Fire Protection Valves:

SIZE	TYPE	CLASS	MANUFACTURER
2" AND SMALLER	BALL	300	NIBCO NO. KT-505-W-8, STOCKHAM NO. T-255-FB-P-UL
2" AND SMALLER	BUTTERFLY	175	MILWAUKEE NO. BB-SC02
2-1/2" AND LARGER	BUTTERFLY (LUG)	250	NIBCO NO. LD3510-8
2-1/2" AND LARGER	BUTTERFLY (GROOVED)	300	NIBCO NO. GD-4765-8N
2 " AND SMALLER	CHECK	200	NIBCO NO. KT-403-W
2-1/2" AND LARGER	CHECK	175	NIBCO NO. F-908-W
2-1/2" AND LARGER	CHECK (GROOVED)	250	NIBCO NO. G-917 W

2.01 WET PIPE FIRE SPRINKLER SYSTEM

A. System Description:

1. System to provide coverage for entire building.
2. Provide system to the NFPA 13 occupancy requirements listed below, unless otherwise noted. Refer to "FP" drawings for locations of design densities of specific rooms and areas.

Location	System Type/Hazard
Administrative and Meeting Rooms	Light Hazard
Mechanical Equipment Rooms	Ordinary Hazard, Group 1
Electrical Equipment Rooms	Ordinary Hazard, Group 1
General Storage Areas	Ordinary Hazard, Group 1

3. Interface system with building fire and smoke alarm system.
4. Systems subject to freezing shall utilize antifreeze liquid. DRY PIPE SYSTEMS ARE NOT ALLOWED.

2.02 SPRINKLER HEADS

A. Acceptable Manufacturers: Victaulic, Grinnell (Tyco), Viking, Star or Reliable.

B. Suspended Ceilings and Gypsum Board or Plaster Ceilings:

1. Type: Concealed pendant type, flexible concealed pendant, quick response.
 - a. Finish: Factory finished (no field painting) cover plate, color to match ceiling finish. Exception: Provide chrome plated or alternate color cover plates where directed by Architect.
 - b. Flexible sprinklers are permitted only in drop ceilings. Flexible sprinkler piping shall have UL-listed braided, angular corrugated flexible sprinkler hose. Hose shall have a minimum 2 inch (50.8 mm). bend radius and hose shall not have any bend connection restrictions without affecting hydraulics and safety of the material.
2. Escutcheon Plate Finish: Standard white or chrome plated as selected by Architect.

3. Operating Element: Fusible solder link or glass bulb type temperature rated for specific area hazard.
4. Model: Sprinklers manufactured by Reliable, Victaulic or approved equal.
- C. Exposed Area Type (for areas such as mechanical rooms, electrical rooms, etc.):
 1. Type: Standard upright or pendent type with guard, quick response.
 2. Head Finish:
 - a. Conditioned spaces: Bronze.
 - b. Non-conditioned Spaces/Exterior: Corrosion resistant material (i.e. PTFE or Electroless Nickel PTFE).
 3. Operating Element: Fusible solder link or glass bulb type temperature rated for specific area hazard.
 4. Model: GFR with appropriate wire guard as manufactured by Reliable or approved equal.
- D. Extended coverage sprinkler heads are not to be used.
- E. Sprinkler heads in elevator hoistways and elevator equipment rooms to be 200 degree F rated.
- F. Use only quick response sprinkler heads.
- G. Cold Rooms ($\leq 42^{\circ}\text{F}$) and Areas Below Heated Ceiling/Soffit Spaces Susceptible to Freezing: Provide dry pendant type with chrome finish and two-piece escutcheon. (Areas include but not limited to; walk-in freezers, exterior overhangs, canopies.)
- H. Elevator Equipment Rooms: Provide 212°F intermediate temperature classified heads.
- I. Water Alarm:
 1. A water motor alarm shall be connected to each alarm valve and shall discharge to a brass alarm gong located on the exterior of the building as directed by the Architect. Alarm gong finish to be selected by the Architect.
 2. The alarm valves shall be Underwriters' Laboratories approved, wet type, connected to water supply and indicated on the Shop Drawings. Each alarm valve shall be provided with a circuit closer. Valves shall conform to the equipment of NFPA 13, complete with retarding chamber and pressure switch.
- J. Water Flow Alarm Switch:
 1. Provide, where indicated on the Drawings, McDonnell UL approved line size flow switches.
 2. Flow switch shall be provided with delay, adjustable up to 90 seconds (60 to 90 seconds in Austin). See Division 26 for electrical signal connection by others to these flow switches.

2.03 FIRE DEPARTMENT SIAMESE CONNECTIONS

- A. At the points designated on the accompanying Drawings, install Siamese fittings required for fire protection purposes. From a point on the incoming water supply line, the Contractor shall extend water line for fire protection purposes to Siamese connections.
- B. Provide 2-way wall type Siamese connection equal to Potter Roemer No. 5750 series double clapper flush type Siamese connections with 2-1/2" outlets having threads complying with the requirements of the Fire Department of the local municipality. They shall have proper caps with pin type lugs attached to the body of the Siamese connections with substantial chains. The plate fitting against the building shall have raised letters reading "AUTOMATIC SPRINKLER". All external surfaces shall be chromium plated polished surfaces or as directed by Architect.
- C. Provide 2 way free standing type Siamese shall be equal to Potter-Romer No. 5760 series cast brass body with 2-1/2" outlets and escutcheon. They shall have proper caps with pin type lugs attached to the body of connection with substantial chains. "AUTOMATIC SPRINKLER" is to be cast on head of connection. All external surfaces shall be chromium plated polished surfaces or as directed by Architect.

- D. Provide hose threads complying with the requirements of the local Fire Department.
- E. Products manufactured by Potter Roemer, Elkhart Brass or Larsen's will be acceptable.

PART 3 EXECUTION

3.01 PREPARATION - ALL SYSTEMS

- 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.
- D. Flush entire system of foreign matter prior to installation of sprinkler heads.

3.02 INSTALLATION

- A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.
- B. Install all materials and products in accordance with manufacturer's published recommendations. Use tools manufactured for the installation of the specific material or product.
- C. Sprinkler Systems
 - 1. Install piping in accordance with NFPA 13 for sprinkler systems and NFPA 24 for service mains. Note that the piping sizes indicated in the plans are the minimum acceptable. The Qualified Contractor shall provide proper sizes, materials and installation as required in the appropriate NFPA Standard.
 - 2. Note that the use of piping bushings for any purpose is explicitly prohibited.
 - 3. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient. See Sections 21 00 00 and 21 05 29 for additional requirements.
 - 4. Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.
 - 5. Locate concealed valves, switches and alarm connections in accessible location, and coordinate size and location of access panels/doors with General Contractor.
 - 6. Install valves with stems upright, not inverted. All valves shall be located such that the removal of their bonnets is possible. Valves placed in horizontal lines shall be installed with their valve stems inclined at an angle of a minimum of 30 degrees above the horizontal position. Valves shall be installed as nearly as possible to the locations indicated in the Construction Drawings. Any change in valve location must be so indicated on the Record Drawings. Remove protective coatings after installation.
 - 7. Provide drain valves at main shut-off valves, low points of piping and apparatus. Provide Fire Department test station, piped to drain.
 - 8. Locate outside alarm gong on building wall as indicated on the Drawings.
 - 9. Place pipe runs to conserve building space, and to minimize obstructions with other work. Group piping whenever practical at common elevations. Coordinate closely with work of other trades to avoid conflicts and provide all required offsets, piping, auxiliary drains, etc. to properly install system.
 - 10. Place piping in concealed spaces above finished ceilings. Run piping as high as possible, but a minimum of 12 inches (304.8 mm) above ceilings or proposed ceilings. Locate piping to avoid obstructing other work, including required service access to equipment furnished by other Divisions.
 - 11. Heads shall be located in a symmetrical pattern related to ceiling features such as grid, beams, light fixtures, diffusers, etc., and where applicable, heads shall be located symmetrically with the ceiling grid, centered in two (2) directions.

12. Provide concealed sprinkler heads in 'public' areas such as corridors, student restrooms, commons, activity areas, locker rooms, etc. Apply paper cover to ensure concealed sprinkler head and cover plates do not receive field paint finish.
13. Provide semi-recessed sprinkler heads at classrooms, office and other staff occupied spaces.
14. Provide exposed sprinkler heads at all areas open to structure.
15. Provide wire guards on heads in all mechanical rooms, gymnasiums, and other areas where heads are subject to damage.
16. Sprinkler drop piping below ceiling configuration should be return bend (NFPA 13, Section 8.15.19) or flexible sprinkler drops shall be oriented such that the branch line connection is facing up.
17. Arm-overs greater than 24 inches (609.6 mm) shall be supported.
18. Install and connect fire pumps in accordance with Section 21 30 00 and NFPA 13.
19. Locate Fire Department Connection with sufficient clearance from walls, obstructions, or adjacent Siamese connectors to allow full swing of Fire Department wrench handle.
20. Inspector's test valves shall be installed for each sprinkler control valve assembly equipped with a flow switch and piped to an acceptable location as defined below. Design installation of inspector's test drain to accommodate the flow of discharge water under full flow conditions with pump running. The test drain is to be closed-pipe with a sight glass located to verify flow. Discharge piping to a remotely located sanitary drain, sump, or equivalent, in accordance with NFPA requirements and not requiring the addition of a hose to accommodate flow within the building. Locate test/drain valves and sight glasses inside stairwells, wherever practicable. Test drain shall not be piped to mop sinks.
21. All black steel piping shall be primed and painted red at factory/fabrication shop. Do not paint threads or fittings.

3.03 WELDED PIPING

- A. Welding of pipe/fittings in normally occupied buildings is prohibited. Offsite welding is acceptable. Should welding be required in a normally occupied building for connecting to an existing welded system, obtain written approval from the Owner and comply with NFPA 51B.
- B. All welding materials, procedures, qualifications and records shall comply with applicable NFPA requirements.

3.04 SYSTEM CLEANING AND FLUSHING

- A. Cleaning, flushing and inspection shall be done in accordance with NFPA requirements.
- B. The installing Contractor shall complete and sign the appropriate Contractor's Material and Test Certificates included within NFPA 13 and 14. Tests and signing of test certificates shall be witnessed by Owner's Construction Inspector or designee.

3.05 ZONING

- A. All flow switches and tamper switches shall relay their activation to each annunciator panel and the main fire alarm panel.
- B. Sprinkler system zoning shall coincide with building smoke compartmentalization unless noted otherwise on Contract Drawings. As a minimum, each floor level shall be a separate zone.

3.06 ACCEPTANCE TESTING

- A. Pre-Acceptance Test: Prior to acceptance of the installation, subject the system to the test procedures as described by National Fire Protection Association Standards Nos. 13 and 24. Test pressures to be 200 psig (1378.95 kPa) minimum and are to be performed with all attached appurtenances. The duration of the test(s) to be a minimum of two (2) hours.
- B. Acceptance Testing: AHJ requires 48 hours advance notice for this test. Upon completion of the installation, subject the system to the test procedures as described by National Fire

Protection Association Standards Nos. 13 and 24 and provide the Owner with a Contractor's material and test certificate for aboveground or underground piping as required therein. Test pressures to be 200 psig (1378.95 kPa) minimum and are to be performed with all attached appurtenances. The duration of the test(s) to be a minimum of two (2) hours. Completely flush new piping system after completion of test. Prior to acceptance testing provide a set of complete shop drawings to verify installation.

3.07 SIGNAGE AND IDENTIFICATION POINTS

- A. Install durable signage to indicate location of all shut-off and test valves. Locate signage in a commonly occupied/traveled location (e.g. hallway). Securely attach signage utilizing chains or other suitable methods. Provide signage with white letters and red background.
- B. Install identification point signage for all hidden water flow switches. Identification tags to be white letters on a red background. Locate in areas visible from hallways.

3.08 TRAINING

- A. Contractor shall provide for the service of a competent, trained and experienced agent to instruct and acquaint the Owner with the proper functioning, operation and maintenance of the fire protection systems and all installed components.

END OF SECTION

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Coordinate with Commissioning Requirements indicated in Section 019100. This contractor is responsible to comply with all requirements for the above section.

1.02 PLUMBING SYSTEM CRITERIA

- A. Domestic hot water temperature shall be limited to 105o F. except for water supplied to kitchen. Kitchens shall have a water supply temperature of 140o F.
- B. Gas piping on roofs shall be supported by manufactured free standing pipe supports.
- C. Water and gas lines under drives and walkways shall be sleeved with schedule 40 PVC, at least two pipe sizes larger than the supply line.
- D. The design of the roof drainage systems shall incorporate roof drains and overflows. The overflow system shall be piped independently and connected vertically to the roof drain down spout. The overflows shall be located in locations readily visible. Discharge overflow above grade as indicated on drawings.
- E. Lavatories serving students shall have single, self closing faucets. Learning Center sinks shall have single faucets with goose necks. All sinks to include cold, tempered and hot water not to exceed 105o F.
- F. In each science learning center/wet lab, provide a red emergency shut off button to shutdown water, gas and electricity in event of an emergency. Locate this button in the teacher's workstation and away from exit door.

1.03 SUMMARY

- A. Design a complete plumbing system including all sanitary, waste and vent piping, storm piping, gas piping and all equipment necessary for a complete system and in accordance with all local jurisdictions and codes.
- B. All materials and distribution, and utilization equipment shall be UL Listed.
- C. All equipment and materials shall be new, unused and of United States Domestic manufacture.
- D. Provide hot and cold and tempered water isolation valves at every supply pipe to each restroom or restroom bank.
- E. Isolation valves shall be accessible in all restrooms. The contractor shall provide a minimum of 2 feet (60.96 cm) accessible pipe chase for maintenance.
- F. All cleanouts shall be accessible. Any room that has a plumbing fixture shall have an accessible isolation valve.
- G. A record shall be kept of all permits and inspections and submitted to the Master Plumber. In addition, a list of all equipment and devices will be provided.
- H. This Section includes the following:
 - 1. Piping materials and installation instructions common to most piping systems.
 - 2. Transition fittings.
 - 3. Dielectric fittings.
 - 4. Mechanical sleeve seals.
 - 5. Sleeves.
 - 6. Escutcheons.
 - 7. Grout.
 - 8. Equipment installation requirements common to equipment sections.

9. Painting and finishing.
10. Concrete bases.
11. Supports and anchorages.

1.04 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspace, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. The following are industry abbreviations for plastic materials:
 1. ABS: Acrylonitrile-butadiene-styrene plastic.
 2. CPVC: Chlorinated polyvinyl chloride plastic.
 3. PE: Polyethylene plastic.
 4. PVC: Polyvinyl chloride plastic.
- G. The following are industry abbreviations for rubber materials:
 1. EPDM: Ethylene-propylene-diene terpolymer rubber.
 2. NBR: Acrylonitrile-butadiene rubber.

1.05 REFERENCE STANDARDS

- A. ASME B1.20.1 - Pipe Threads, General Purpose, Inch; 2013 (Reaffirmed 2018).
- B. ASME B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges; 2021.
- C. ASME B18.2.1 - Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series); 2012 (Reaffirmed 2021).
- D. ASTM B32 - Standard Specification for Solder Metal; 2020.
- E. ASTM B813 - Standard Specification for Water Flushable Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube; 2024.
- F. ASTM B828 - Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings; 2023.
- G. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120; 2021a.
- H. ASTM D2235 - Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings; 2022.
- I. ASTM D2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems; 2020 (Reapproved 2024).
- J. ASTM D2657 - Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings; 2007 (Reapproved 2023).
- K. ASTM D2661 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings; 2024.

- L. ASTM D2846/D2846M - Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Hot- and Cold-Water Distribution Systems; 2024.
- M. 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 (Reapproved 2024).
- N. ASTM D3139 - Standard Specification for Joints for Plastic Pressure Pipes using Flexible Elastomeric Seals; 2019 (Reapproved 2025).
- O. ASTM F402 - Standard Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings; 2026.
- P. ASTM F493 - Standard Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings; 2022 (Reapproved 2026).
- Q. ASTM F656 - Standard Specification for Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) and Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings; 2025.
- R. AWWA C219 - Bolted Sleeve-Type Couplings for Plain-End Pipe; 2023.

1.06 SUBMITTALS

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

1.07 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.09 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for plumbing installations.
- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

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

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.02 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.03 JOINING MATERIALS

- A. Refer to individual Division 22 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 - 1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
 - 2. AWWA C110, rubber, flat face, 1/8 inch (3.18 mm) thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- E. Solder Filler Metals: ASTM B32, lead-free alloys. Include water-flushable flux according to ASTM B813.
- F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
- G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- H. Solvent Cements for Joining Plastic Piping:
 - 1. ABS Piping: ASTM D2235.
 - 2. CPVC Piping: ASTM F493.
 - 3. PVC Piping: ASTM D2564. Include primer according to ASTM F656.
 - 4. PVC to ABS Piping Transition: ASTM D 3138.
- I. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

2.04 TRANSITION FITTINGS

- A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.
 - 1. Manufacturers:
 - a. Cascade Waterworks Mfg. Co.
 - b. Dresser Industries, Inc.; DMD Div.
 - c. Ford Meter Box Company, Incorporated (The); Pipe Products Div.

- d. JCM Industries.
 - e. Smith-Blair, Inc.
 - f. Viking Johnson.
- 2. Underground Piping NPS 1-1/2 and Smaller: Manufactured fitting or coupling.
- 3. Underground Piping NPS 2 and Larger: AWWA C219, metal sleeve-type coupling.
- 4. Aboveground Pressure Piping: Pipe fitting.
- B. Plastic-to-Metal Transition Fittings: CPVC and PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
 - 1. Manufacturers:
 - a. Eslon Thermoplastics.
- C. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
 - 1. Manufacturers:
 - a. Thompson Plastics, Inc.
- D. Plastic-to-Metal Transition Unions: MSS SP-107, CPVC PVC CPVC and PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.
 - 1. Manufacturers:
 - a. NIBCO INC.
 - b. NIBCO, Inc.; Chemtrol Div.
- E. Flexible Transition Couplings for Underground Non-pressure Drainage Piping: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.
 - 1. Manufacturers:
 - a. Cascade Waterworks Mfg. Co.
 - b. Fernco, Inc.
 - c. Mission Rubber Company.
 - d. Plastic Oddities, Inc.

2.05 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F
- D. Coordinate subparagraph and associated subparagraphs below with Part 2 "Manufacturers" Article. Retain "Available" for nonproprietary and delete for semiproprietary specifications.
 - 1. Manufacturers:
 - a. Capitol Manufacturing Co.
 - b. Central Plastics Company.
 - c. Eclipse, Inc.
 - d. Epco Sales, Inc.
 - e. Hart Industries, International, Inc.
 - f. Watts Industries, Inc.; Water Products Div.
 - g. Zurn Industries, Inc.; Wilkins Div.
- E. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
 - 1. Manufacturers:
 - a. Capitol Manufacturing Co.

- b. Central Plastics Company.
 - c. Epco Sales, Inc.
 - d. Watts Industries, Inc.; Water Products Div.
- F. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
 - 1. Manufacturers:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Central Plastics Company.
 - d. Pipeline Seal and Insulator, Inc.
 - 2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.
- G. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F
 - 1. Manufacturers:
 - a. Calpico, Inc.
 - b. Lochinvar Corp.
- H. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.
 - 1. Manufacturers:
 - a. Perfection Corp.
 - b. Precision Plumbing Products, Inc.
 - c. Sioux Chief Manufacturing Co., Inc.
 - d. Victaulic Co. of America.

2.06 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
 - 1. Manufacturers:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Metraflex Co.
 - d. Pipeline Seal and Insulator, Inc.
 - 2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 3. Pressure Plates: Carbon steel. Include two for each sealing element.
 - 4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.07 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral water-stop, unless otherwise indicated.
- D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
 - 1. Under-deck Clamp: Clamping ring with set screws.
- E. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.

- F. PVC Pipe: ASTM D1785, Schedule 40.
- G. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

2.08 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Cast-Brass Type: With set screw.
 - 1. Finish: Polished chrome-plated.
- D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
 - 1. Finish: Polished chrome-plated.
- E. One-Piece, Stamped-Steel Type: With set screw set screw or spring clips and chrome-plated finish.
- F. Split-Plate, Stamped-Steel Type: With concealed hinge, set screw or spring clips, and chrome-plated finish.
- G. One-Piece, Floor-Plate Type: Cast-iron floor plate.
- H. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.09 GROUT

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

PART 3 EXECUTION

3.01 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.

-
- K. Select system components with pressure rating equal to or greater than system operating pressure.
 - L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
 - 1. New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
 - c. Insulated Piping: One-piece, stamped-steel type with spring clips.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
 - f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - g. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - h. Bare Piping in Equipment Rooms: One-piece, cast-brass type.
 - i. Bare Piping in Equipment Rooms: One-piece, stamped-steel type with set screw or spring clips.
 - j. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
 - M. Sleeves are not required for core-drilled holes.
 - N. Permanent sleeves are not required for holes formed by removable PE sleeves.
 - O. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.
 - P. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50.8 mm) above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 - 2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
 - 3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
 - a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
 - b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
 - c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50.8 mm) above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.
 - 1) Seal space outside of sleeve fittings with grout.
 - 4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.
 - Q. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 1. Install steel pipe for sleeves smaller than 6 inches (152.4 mm) in diameter.
 - 2. Install cast-iron "wall pipes" for sleeves 6 inches (152.4 mm) and larger in diameter.

3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- R. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- S. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire stop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.
- T. Verify final equipment locations for roughing-in.
- U. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.02 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
 2. ABS Piping: Join according to ASTM D2235 and ASTM D2661 Appendixes.
 3. CPVC Piping: Join according to ASTM D2846/D2846M Appendix.

4. PVC Pressure Piping: Join schedule number ASTM D1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D2855.
5. PVC Non-pressure Piping: Join according to ASTM D2855.
6. PVC to ABS Non-pressure Transition Fittings: Join according to ASTM D 3138 Appendix.
- J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D3139.
- K. Plastic Non-pressure Piping Gasketed Joints: Join according to ASTM D 3212.
- L. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D2657.
 1. Plain-End Pipe and Fittings: Use butt fusion.
 2. Plain-End Pipe and Socket Fittings: Use socket fusion.
- M. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

3.03 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
 3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
 4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.04 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

3.05 PAINTING

- A. Painting of plumbing systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."
- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.06 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
 1. Construct concrete bases of dimensions indicated, but not less than 4 inches (101.6 mm) larger in both directions than supported unit.
 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.

4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete."

3.07 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 05 Section "Metal Fabrications" for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

3.08 GROUTING

- A. Mix and install grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

END OF SECTION

SECTION 22 05 23.12

BALL VALVES FOR PLUMBING PIPING

PART 1 GENERAL

3.01 RELATED DOCUMENTS

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

3.02 SUMMARY

- A. Section Includes:
 - 1. Brass ball valves.
 - 2. Bronze ball valves.

3.03 DEFINITIONS

- A. CWP: Cold working pressure.

3.04 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; 2026.
- C. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24 Metric/Inch Standard; 2025.
- D. ASME B16.10 - Face-to-Face and End-to-End Dimensions of Valves; 2022, with Errata (2023).
- E. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2021.
- F. ASME B16.34 - Valves — Flanged, Threaded, and Welding End; 2025.
- G. ASME B31.9 - Building Services Piping; 2025.
- H. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications; 2022.
- I. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; 2010, with Errata .
- J. NSF 61 - Drinking Water System Components - Health Effects; 2025, with Addendum
- K. NSF 372 - Drinking Water System Components - Lead Content; 2024.

3.05 ACTION SUBMITTALS

- A. Product Data: For each type of valve.
 - 1. Certification that products comply with NSF 61 and NSF 372.

3.06 DELIVERY, STORAGE, AND HANDLING

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

PART 2 PRODUCTS

4.01 GENERAL REQUIREMENTS FOR VALVES

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
 - 1. ASME B1.20.1 for threads for threaded end valves.
 - 2. ASME B16.1 for flanges on iron valves.
 - 3. ASME B16.5 for flanges on steel valves.
 - 4. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 - 5. ASME B16.18 for solder-joint connections.
 - 6. ASME B31.9 for building services piping valves.
- C. NSF Compliance: NSF 61 and NSF 372 for valve materials for potable-water service.
- D. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.
- E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- F. Valve Sizes: Same as upstream piping unless otherwise indicated.
- G. Valve Actuator Types:
 - 1. Gear Actuator: For quarter-turn valves NPS 4 and larger.
 - 2. Handlever: For quarter-turn valves smaller than NPS 4.
- H. Valves in Insulated Piping:
 - 1. Include 2-inch stem extensions.
 - 2. Extended operating handles of nonthermal-conductive material and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation.
 - 3. Memory stops that are fully adjustable after insulation is applied.

4.02 BRASS BALL VALVES

- A. Brass Ball Valves, One-Piece:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. KITZ Corporation.
 - b. WATTS.
 - 2. Description:
 - a. Standard: MSS SP-110.
 - b. CWP Rating: 400 psig (2757.90 kPa).
 - c. Body Design: One piece.
 - d. Body Material: Forged brass or bronze.
 - e. Ends: Threaded and soldered.
 - f. Seats: PTFE.
 - g. Stem: Brass or stainless steel.
 - h. Ball: Chrome-plated brass or stainless steel.
 - i. Port: Reduced.
- B. Brass Ball Valves, Two-Piece with Full Port and Brass Trim, Threaded or Soldered Ends:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Valve, Inc.
 - b. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - c. Center Line; a Crane Co. brand.

-
- d. Hammond Valve.
 - e. Jenkins Valves; a Crane Co. brand.
 - f. KITZ Corporation.
 - g. Milwaukee Valve Company.
 - h. Stockham; a Crane Co. brand.
 - i. WATTS.
 - 2. Description:
 - a. Standard: MSS SP-110 or MSS SP-145.
 - b. CWP Rating: 600 psig (4136.86 kPa).
 - c. Body Design: Two piece.
 - d. Body Material: Forged brass.
 - e. Ends: Threaded and soldered.
 - f. Seats: PTFE.
 - g. Stem: Brass.
 - h. Ball: Chrome-plated brass.
 - i. Port: Full.
 - C. Brass Ball Valves, Two-Piece with Regular Port and Brass Trim:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - b. Center Line; a Crane Co. brand.
 - c. Hammond Valve.
 - d. KITZ Corporation.
 - e. Milwaukee Valve Company.
 - f. Red-White Valve Corp.
 - g. Stockham; a Crane Co. brand.
 - h. WATTS.
 - 2. Description:
 - a. Standard: MSS SP-110.
 - b. CWP Rating: 600 psig (4136.86 kPa).
 - c. Body Design: Two piece.
 - d. Body Material: Forged brass.
 - e. Ends: Threaded and soldered.
 - f. Seats: PTFE.
 - g. Stem: Brass.
 - h. Ball: Chrome-plated brass.
 - i. Port: Regular.

4.03 BRONZE BALL VALVES

- A. Bronze Ball Valves, One-Piece with Bronze Trim:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. NIBCO INC.
 - b. WATTS.
 - 2. Description:
 - a. Standard: MSS SP-110.
 - b. CWP Rating: 400 psig (2757.90 kPa).
 - c. Body Design: One piece.
 - d. Body Material: Bronze.
 - e. Ends: Threaded.

- f. Seats: PTFE.
 - g. Stem: Bronze.
 - h. Ball: Chrome-plated brass.
 - i. Port: Reduced.
- B. Bronze Ball Valves, One-Piece with Stainless-Steel Trim:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. NIBCO INC.
 - b. WATTS.
 - 2. Description:
 - a. Standard: MSS SP-110.
 - b. CWP Rating: 600 psig (4136.86 kPa).
 - c. Body Design: One piece.
 - d. Body Material: Bronze.
 - e. Ends: Threaded.
 - f. Seats: PTFE.
 - g. Stem: Stainless steel.
 - h. Ball: Stainless steel, vented.
 - i. Port: Reduced.
- C. Bronze Ball Valves, Two-Piece with Full Port, and Bronze or Brass Trim, Threaded or Soldered Ends:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - b. Center Line; a Crane Co. brand.
 - c. Hammond Valve.
 - d. Jenkins Valves; a Crane Co. brand.
 - e. Milwaukee Valve Company.
 - f. NIBCO INC.
 - g. Red-White Valve Corp.
 - h. Stockham; a Crane Co. brand.
 - i. WATTS.
 - j. Zurn Industries, LLC.
 - 2. Description:
 - a. Standard: MSS SP-110 or MSS-145.
 - b. CWP Rating: 600 psig (4136.86 kPa).
 - c. Body Design: Two piece.
 - d. Body Material: Bronze.
 - e. Ends: Threaded and soldered.
 - f. Seats: PTFE.
 - g. Stem: Bronze or brass.
 - h. Ball: Chrome-plated brass.
 - i. Port: Full.
- D. Bronze Ball Valves, Two-Piece with Full Port, and Bronze or Brass Trim, Press Ends:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - b. Center Line; a Crane Co. brand.
 - c. Hammond Valve.
 - d. Milwaukee Valve Company.

- e. NIBCO INC.
 - f. Red-White Valve Corp.
 - g. Stockham; a Crane Co. brand.
 - h. Viega LLC.
 - 2. Description:
 - a. Standard: MSS SP-110 or MSS-145.
 - b. CWP Rating: Minimum 200 psig (1378.95 kPa).
 - c. Body Design: Two piece.
 - d. Body Material: Bronze.
 - e. Ends: Press.
 - f. Press Ends Connections Rating: Minimum 200 psig (1378.95 kPa).
 - g. Seats: PTFE or RTPFE.
 - h. Stem: Bronze or brass.
 - i. Ball: Chrome-plated brass.
 - j. Port: Full.
 - k. O-Ring Seal: EPDM or Buna-N.
- E. Bronze Ball Valves, Two-Piece with Full Port and Stainless-Steel Trim:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - b. Center Line; a Crane Co. brand.
 - c. DynaQuip Controls.
 - d. Hammond Valve.
 - e. Jenkins Valves; a Crane Co. brand.
 - f. Milwaukee Valve Company.
 - g. NIBCO INC.
 - h. Red-White Valve Corp.
 - i. Stockham; a Crane Co. brand.
 - j. Viega LLC.
 - k. WATTS.
 - 2. Description:
 - a. Standard: MSS SP-110 or MSS-145.
 - b. CWP Rating: 600 psig (4136.86 kPa).
 - c. Body Design: Two piece.
 - d. Body Material: Bronze.
 - e. Ends: Threaded or soldered.
 - f. Seats: PTFE.
 - g. Stem: Stainless steel.
 - h. Ball: Stainless steel, vented.
 - i. Port: Full.
- F. Bronze Ball Valves, Two-Piece with Regular Port and Bronze or Brass Trim:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Valve, Inc.
 - b. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - c. Center Line; a Crane Co. brand.
 - d. DynaQuip Controls.
 - e. Hammond Valve.
 - f. Jenkins Valves; a Crane Co. brand.
 - g. Lance Valves.

- h. Milwaukee Valve Company.
 - i. NIBCO INC.
 - j. Red-White Valve Corp.
 - k. Stockham; a Crane Co. brand.
 - l. Viega LLC.
 - 2. Description:
 - a. Standard: MSS SP-110.
 - b. CWP Rating: 600 psig (4136.86 kPa).
 - c. Body Design: Two piece.
 - d. Body Material: Bronze.
 - e. Ends: Threaded.
 - f. Seats: PTFE.
 - g. Stem: Bronze or brass.
 - h. Ball: Chrome-plated brass.
 - i. Port: Regular.
- G. Bronze Ball Valves, Two-Piece with Regular Port and Stainless-Steel Trim:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - b. Center Line; a Crane Co. brand.
 - c. DynaQuip Controls.
 - d. Hammond Valve.
 - e. Jenkins Valves; a Crane Co. brand.
 - f. Milwaukee Valve Company.
 - g. NIBCO INC.
 - h. Red-White Valve Corp.
 - i. Stockham; a Crane Co. brand.
 - j. Viega LLC.
 - 2. Description:
 - a. Standard: MSS SP-110.
 - b. CWP Rating: 600 psig (4136.86 kPa).
 - c. Body Design: Two piece.
 - d. Body Material: Bronze.
 - e. Ends: Threaded.
 - f. Seats: PTFE.
 - g. Stem: Stainless steel.
 - h. Ball: Stainless steel, vented.
 - i. Port: Regular.
- H. Bronze Ball Valves, Three-Piece with Regular Port and Stainless-Steel Trim:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - b. NIBCO INC.
 - 2. Description:
 - a. Standard: MSS SP-110.
 - b. CWP Rating: 600 psig (4136.86 kPa).
 - c. Body Design: Three piece.
 - d. Body Material: Bronze.
 - e. Ends: Threaded or soldered.
 - f. Seats: PTFE.

- g. Stem: Stainless steel.
 - h. Ball: Stainless steel, vented.
 - i. Port: Regular.
- I. Bronze Ball Valves, Two-Piece, Safety-Exhaust:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - b. DynaQuip Controls.
 - c. Lance Valves.
 - 2. Description:
 - a. Standard: MSS SP-110.
 - b. CWP Rating: 600 psig (4136.86 kPa).
 - c. Body Design: Two piece.
 - d. Body Material: Bronze, ASTM B584, Alloy C844.
 - e. Ends: Threaded.
 - f. Seats: PTFE.
 - g. Stem: Stainless steel.
 - h. Ball: Chrome-plated brass, with exhaust vent opening for pneumatic applications.
 - i. Port: Full.

PART 3 EXECUTION

5.01 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

5.02 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install valve tags. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

5.03 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.
- B. Select valves with the following end connections:
 - 1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option or press-end option is indicated in valve schedules below.

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

5.04 LOW-PRESSURE, COMPRESSED-AIR VALVE SCHEDULE (150 PSIG OR LESS)

- A. Pipe NPS 2 and Smaller:
 1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
 2. Brass ball valves, one piece.
 3. Bronze ball valves, one piece with stainless steel trim.
 4. Brass ball valves, two-piece with full port and stainless steel trim.
- B. Pipe NPS 2-1/2 (DN 65) and Larger:
 1. Steel and Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
 2. Steel ball valves, Class 150 with full port.
 3. Iron ball valves, Class 150.

5.05 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

- A. Pipe NPS 2 and Smaller:
 1. Brass ball valve, one piece. Provide with threaded or solder-joint ends.
 2. Bronze ball valve, one piece with stainless steel trim. Provide with threaded solder-joint ends.
 3. Brass ball valves, two-piece with full port and stainless steel trim. Provide with solder -joint ends.
- B. Pipe NPS 2-1/2 and Larger:
 1. Steel and Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
 2. Steel ball valves, Class 150 with full port.
 3. Iron ball valves, Class 150.

END OF SECTION

SECTION 22 05 23.14

CHECK VALVES FOR PLUMBING PIPING

PART 1 GENERAL

3.01 RELATED DOCUMENTS

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

3.02 SUMMARY

- A. Section Includes:
 - 1. Bronze lift check valves.
 - 2. Bronze swing check valves.
 - 3. Bronze swing check valves, press ends.

3.03 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene-diene terpolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

3.04 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; 2026.
- C. ASME B16.10 - Face-to-Face and End-to-End Dimensions of Valves; 2022, with Errata (2023).
- D. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2021.
- E. ASME B16.34 - Valves — Flanged, Threaded, and Welding End; 2025.
- F. ASME B31.9 - Building Services Piping; 2025.
- G. ASTM B61 - Standard Specification for Steam or Valve Bronze Castings; 2015 (Reapproved 2021).
- H. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings; 2017 (Reapproved 2025).
- I. AWWA C606 - Grooved and Shouldered Joints; 2022.
- J. MSS SP-45 - Drain and Bypass Connections; 2020.
- K. MSS SP-80 - Bronze Gate, Globe, Angle, and Check Valves; 2019.
- L. NSF 61 - Drinking Water System Components - Health Effects; 2025, with Addendum
- M. NSF 372 - Drinking Water System Components - Lead Content; 2024.

3.05 ACTION SUBMITTALS

- A. Product Data: For each type of valve.
 - 1. Certification that products comply with NSF 61 and NSF 372.

3.06 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, grooves, and weld ends.
 - 3. Set check valves in either closed or open position.
- B. Use the following precautions during storage:
 - 1. Maintain valve end protection.

2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 PRODUCTS

4.01 GENERAL REQUIREMENTS FOR VALVES

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
 1. ASME B1.20.1 for threads for threaded end valves.
 2. ASME B16.1 for flanges on iron valves.
 3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 4. ASME B16.18 for solder joint.
 5. ASME B31.9 for building services piping valves.
- C. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.
- D. Drinking Water System Components - Health Effects and Drinking Water System Components - Lead Content Compliance: NSF 61 and NSF 372.
- E. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.
- F. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- G. Valve Sizes: Same as upstream piping unless otherwise indicated.
- H. Valve Bypass and Drain Connections: MSS SP-45.

4.02 BRONZE LIFT CHECK VALVES

- A. Bronze Lift Check Valves with Bronze Disc, Class 125:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane; a Crane brand.
 - b. Jenkins Valves; a Crane Co. brand.
 - c. Stockham; a Crane Co. brand.
 2. Description:
 - a. Standard: MSS SP-80, Type 1.
 - b. CWP Rating: 200 psig (1378.95 kPa).
 - c. Body Design: Vertical flow.
 - d. Body Material: ASTM B61 or ASTM B62, bronze.
 - e. Ends: Threaded or soldered. See valve schedule articles.
 - f. Disc: Bronze.
- B. Bronze Lift Check Valves with Nonmetallic Disc, Class 125:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Flo Fab Inc.
 - b. Hammond Valve.
 - c. KITZ Corporation.
 - d. Milwaukee Valve Company.
 - e. Mueller Steam Specialty; A WATTS Brand.
 - f. NIBCO INC.
 - g. Red-White Valve Corp.

- h. WATTS.
- 2. Description:
 - a. Standard: MSS SP-80, Type 2.
 - b. CWP Rating: 200 psig (1378.95 kPa).
 - c. Body Design: Vertical flow.
 - d. Body Material: ASTM B61 or ASTM B62, bronze.
 - e. Ends: Threaded or soldered. See valve schedule articles.
 - f. Disc: NBR, PTFE.

4.03 BRONZE SWING CHECK VALVES

- A. Bronze Swing Check Valves with Bronze Disc, Class 125:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Valve, Inc.
 - b. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - c. Crane; a Crane brand.
 - d. Hammond Valve.
 - e. Jenkins Valves; a Crane Co. brand.
 - f. KITZ Corporation.
 - g. Macomb Groups (The).
 - h. Milwaukee Valve Company.
 - i. NIBCO INC.
 - j. Powell Valves.
 - k. Red-White Valve Corp.
 - l. Stockham; a Crane Co. brand.
 - m. WATTS.
 - 2. Description:
 - a. Standard: MSS SP-80, Type 3.
 - b. CWP Rating: 200 psig (1378.95 kPa).
 - c. Body Design: Horizontal flow.
 - d. Body Material: ASTM B62, bronze.
 - e. Ends: Threaded or soldered. See valve schedule articles.
 - f. Disc: Bronze.
- B. Bronze Swing Check Valves with Nonmetallic Disc, Class 125:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - b. Crane; a Crane brand.
 - c. Hammond Valve.
 - d. Jenkins Valves; a Crane Co. brand.
 - e. KITZ Corporation.
 - f. Milwaukee Valve Company.
 - g. NIBCO INC.
 - h. Red-White Valve Corp.
 - i. Stockham; a Crane Co. brand.
 - j. WATTS.
 - 2. Description:
 - a. Standard: MSS SP-80, Type 4.
 - b. CWP Rating: 200 psig (1378.95 kPa).
 - c. Body Design: Horizontal flow.

- d. Body Material: ASTM B62, bronze.
 - e. Ends: Threaded or soldered. See valve schedule articles.
 - f. Disc: PTFE.
- C. Bronze Swing Check Valves with Bronze Disc, Class 150:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Valve, Inc.
 - b. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - c. Crane; a Crane brand.
 - d. Jenkins Valves; a Crane Co. brand.
 - e. Jomar Valve.
 - f. KITZ Corporation.
 - g. Macomb Groups (The).
 - h. Milwaukee Valve Company.
 - i. NIBCO INC.
 - j. Red-White Valve Corp.
 - k. Stockham; a Crane Co. brand.
 - 2. Description:
 - a. Standard: MSS SP-80, Type 3.
 - b. CWP Rating: 300 psig (2068.43 kPa).
 - c. Body Design: Horizontal flow.
 - d. Body Material: ASTM B62, bronze.
 - e. Ends: Threaded or soldered. See valve schedule articles.
 - f. Disc: Bronze.
- D. Bronze Swing Check Valves with Nonmetallic Disc, Class 150:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane; a Crane brand.
 - b. FNW; Ferguson Enterprises, Inc.
 - c. Hammond Valve.
 - d. Jenkins Valves; a Crane Co. brand.
 - e. Milwaukee Valve Company.
 - f. NIBCO INC.
 - g. WATTS.
 - 2. Description:
 - a. Standard: MSS SP-80, Type 4.
 - b. CWP Rating: 300 psig (2068.43 kPa).
 - c. Body Design: Horizontal flow.
 - d. Body Material: ASTM B62, bronze.
 - e. Ends: Threaded or soldered. See valve schedule articles.
 - f. Disc: PTFE.

PART 3 EXECUTION

5.01 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

5.02 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Check Valves: Install check valves for proper direction of flow.
 - 1. Swing Check Valves: In horizontal position with hinge pin level.
 - 2. Center-Guided and Plate-Type Check Valves: In horizontal or vertical position, between flanges.
 - 3. Lift Check Valves: With stem upright and plumb.
- F. Install valve tags. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

5.03 ADJUSTING

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

5.04 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valve applications are not indicated, use the following:
 - 1. Pump-Discharge Check Valves:
 - a. NPS 2 and Smaller: Bronze swing check valves with bronze disc.
 - b. NPS 2-1/2 and Larger for Domestic Water: Iron swing check valves with lever and weight or spring; or iron, center-guided, metal-seat resilient-seat check valves.
 - c. NPS 2-1/2 and Larger for Sanitary Waste and Storm Drainage: Iron swing check valves with lever and weight or spring.
- B. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.
- C. End Connections:
 - 1. For Copper Tubing, NPS 2 and Smaller: Threaded or soldered or press-ends.
 - 2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged or threaded.
 - 3. For Copper Tubing, NPS 5 and Larger: Flanged.
 - 4. For Steel Piping, NPS 2 and Smaller: Threaded.
 - 5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged or threaded.
 - 6. For Steel Piping, NPS 5 and Larger: Flanged.
 - 7. For Grooved-End Steel Piping: Grooved.

5.05 LOW-PRESSURE, COMPRESSED-AIR VALVE SCHEDULE (150 PSIG OR LESS)

- A. Pipe NPS 2 and Smaller:
 - 1. Vertical, Up flow Applications Only: Bronze lift check valves with bronze disc, Class 125, with soldered or threaded end connections.
 - 2. Horizontal and Vertical Applications: Bronze swing check valves with bronze disc, Class 150, with soldered or threaded end connections.
- B. Pipe NPS 2-1/2 and Larger:

1. Iron swing check valves with metal seats, Class 125, with flanged end connections.
2. Iron, grooved-end swing check valves, 300 CWP.

5.06 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

- A. Pipe NPS 2 and Smaller:
 1. Bronze swing check valves with bronze nonmetallic disc, Class 150, with soldered or threaded end connections.
 2. Bronze swing check valves with press-end connections.
- B. Pipe NPS 2-1/2 and Larger:
 1. Iron swing check valves with metal seats, Class 125 flanged end connections.
 2. Iron swing check valves with closure control lever and spring, Class 125, with flanged end connections.
 3. Iron, grooved-end swing check valves, 300 CWP.

END OF SECTION

SECTION 22 05 29

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

3.01 REFERENCE STANDARDS

- A. ASME B31.9 - Building Services Piping; 2025.
- B. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.
- C. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications; 2026.
- D. ASTM A780/A780M - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings; 2020.
- E. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength; 2025.
- F. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.
- G. ASTM C1107/C1107M - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink); 2020.
- H. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2025, with Amendment (2026).
- I. MFMA-4 - Metal Framing Standards Publication; 2004.
- J. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2025.
- K. SSPC-PA 1 - Shop, Field, and Maintenance Coating of Metals; 2024, with Errata (2025).

3.02 RELATED DOCUMENTS

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

3.03 SUMMARY

- A. Section Includes:
 - 1. Metal pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Metal framing systems.
 - 4. Thermal hanger-shield inserts.
 - 5. Fastener systems.
 - 6. Pipe stands.
 - 7. Equipment supports.
- B. Related Requirements:
 - 1. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.

3.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
 - 1. Trapeze pipe hangers.
 - 2. Metal framing systems.
 - 3. Fiberglass strut systems.

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

3.05 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

3.06 QUALITY ASSURANCE

- A. Structural-Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M.
- B. Pipe Welding Qualifications: Qualify procedures and operators according to 2015 ASME Boiler and Pressure Vessel Code, Section IX.

PART 2 PRODUCTS

4.01 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design trapeze pipe hangers and equipment supports.
- B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7
 1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

4.02 METAL PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports:
 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 2. Galvanized Metallic Coatings: Pregalvanized, hot-dip galvanized, or electro-galvanized.
 3. Nonmetallic Coatings: Plastic coated or epoxy powder coated.
 4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
 5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
- B. Stainless-Steel Pipe Hangers and Supports:
 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
 3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel material.
- C. Copper Pipe and Tube Hangers:
 1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
 2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel material.

4.03 TRAPEZE PIPE HANGERS

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

4.04 METAL FRAMING SYSTEMS

- A. MFMA Manufacturer Metal Framing Systems:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ABB, Electrification Products Division.
 - b. B-line; Eaton, Electrical Sector.
 - c. Flex-Strut Inc.
 - d. G-Strut.
 - e. Haydon Corporation.
 - f. Unistrut; Atkore International.
 - g. Wesanco, Inc.
 - 2. Description: Shop- or field-fabricated pipe-support assembly, made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
 - 3. Standard: Comply with MFMA-4, factory-fabricated components for field assembly.
 - 4. Channels: Continuous slotted carbon-steel channel with inturned lips.
 - 5. Channel Width: Selected for applicable load criteria.
 - 6. Channel Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
 - 7. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
 - 8. Metallic Coating: Electroplated zinc or Hot-dip galvanized.
 - 9. Plastic Coating: PVC.

4.05 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hilti, Inc.
 - b. ITW Ramset/Red Head; Illinois Tool Works, Inc.
 - c. MKT Fastening, LLC.
 - d. Simpson Strong-Tie Co., Inc.
- B. Mechanical-Expansion Anchors: Insert-wedge-type anchors, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. B-line; Eaton, Electrical Sector.
 - b. Empire Tool and Manufacturing Co., Inc.
 - c. Hilti, Inc.
 - d. ITW Ramset/Red Head; Illinois Tool Works, Inc.
 - e. MKT Fastening, LLC.
 - 2. Indoor Applications: Zinc-coated steel.
 - 3. Outdoor Applications: Stainless steel.

4.06 PIPE STANDS

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

- B. Compact Pipe Stand:
 - 1. Description: Single base unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
 - 2. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate.
 - 3. Hardware: Galvanized steel or polycarbonate.
 - 4. Accessories: Protection pads.
- C. Low-Profile, Single-Base, Single-Pipe Stand:
 - 1. Description: Single base with vertical and horizontal members, and pipe support, for roof installation without membrane protection.
 - 2. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate.
 - 3. Vertical Members: Two galvanized-steel, continuous-thread, 1/2-inch rods.
 - 4. Horizontal Member: Adjustable horizontal, galvanized-steel pipe support channels.
 - 5. Pipe Supports: Strut clamps.
 - 6. Hardware: Stainless steel.
 - 7. Accessories: Protection pads.
 - 8. Height: 18 inches (457.2 mm) above roof.
- D. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

4.07 PIPE-POSITIONING SYSTEMS

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

4.08 EQUIPMENT SUPPORTS

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

4.09 MATERIALS

- A. Aluminum: ASTM B221.
- B. Carbon Steel: ASTM A1011/A1011M.
- C. Structural Steel: ASTM A36/A36M carbon-steel plates, shapes, and bars; black and galvanized.
- D. Stainless Steel: ASTM A240/A240M.
- E. Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Non-staining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 EXECUTION

5.01 APPLICATION

- A. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation, for penetrations through fire-rated walls, ceilings, and assemblies.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

5.02 HANGER AND SUPPORT INSTALLATION

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

-
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size, or install intermediate supports for smaller-diameter pipes as specified for individual pipe hangers.
 - 2. Field fabricate from ASTM A36/A36M carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
 - C. Fastener System Installation:
 - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches (101.6 mm) thick in concrete, after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 - 2. Install mechanical-expansion anchors in concrete, after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
 - D. Pipe Stand Installation:
 - 1. Pipe Stand Types, except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
 - 2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 077200 "Roof Accessories" for curbs.
 - E. Pipe-Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.
 - F. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
 - G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
 - H. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
 - I. Install lateral bracing with pipe hangers and supports to prevent swaying.
 - J. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 (DN 65) and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms, and install reinforcing bars through openings at top of inserts.
 - K. Load Distribution: Install hangers and supports, so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
 - L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
 - M. Insulated Piping:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating Above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating Below Ambient Air Temperature: Use thermal hanger-shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
 - 2. Install MSS SP-58, Type 39 protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

- a. Option: Thermal hanger-shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
- 3. Install MSS SP-58, Type 40 protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal hanger-shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
- 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches (304.8 mm) long and 0.048 inch (1.22 mm) thick.
 - b. NPS 4: 12 inches (304.8 mm) long and 0.06 inch (1.52 mm) thick.
 - c. NPS 5 and NPS 6: 18 inches (457.2 mm) long and 0.06 inch (1.52 mm) thick.

5.03 EQUIPMENT SUPPORTS

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

5.04 METAL FABRICATIONS

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

5.05 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches (38 mm).

5.06 PAINTING

- A. Touchup: Clean field welds and abraded, shop-painted areas. Paint exposed areas immediately after erecting hangers and supports. Use same materials as those used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils 0 inch (0.05 mm).
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A780/A780M.

5.07 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.

-
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finishes.
 - D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
 - E. Use carbon-steel pipe hangers and supports and attachments for general service applications.
 - F. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.
 - G. Use padded hangers for piping that is subject to scratching.
 - H. Use thermal hanger-shield inserts for insulated piping and tubing.
 - I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated, stationary pipes NPS 1/2 to NPS 30.
 - 2. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches (101.6 mm) of insulation.
 - 3. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
 - 4. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
 - 5. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
 - 6. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
 - 7. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
 - 8. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
 - J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
 - 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
 - K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Steel Turnbuckles (MSS Type 13): For adjustment of up to 6 inches (152.4 mm) for heavy loads.
 - 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 - 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11 split pipe rings.
 - 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 - 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
 - L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Steel or Malleable-Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 - 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction, to attach to top flange of structural shape.

-
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal Hanger-Shield Inserts: For supporting insulated pipe.
- N. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
 2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches (32 mm).
 3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
 4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
 5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
 6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
 7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
 8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include

auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

- a. Horizontal (MSS Type 54): Mounted horizontally.
 - b. Vertical (MSS Type 55): Mounted vertically.
 - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- O. Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
 - P. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
 - Q. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.
 - R. Use pipe-positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION

SECTION 22 05 53

IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

3.01 REFERENCE STANDARDS

- A. ASME A13.1 - Scheme for the Identification of Piping Systems; 2023.
- B. NFPA 70E - Standard for Electrical Safety in the Workplace; 2024.
- C. NFPA 99 - Health Care Facilities Code; 2024, with Errata.

3.02 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Warning tape.
 - 4. Pipe labels.
 - 5. Stencils.
 - 6. Valve tags.
 - 7. Warning tags.
- B. Related Requirements:
 - 1. Section 226113 "Compressed-Air Piping for Laboratory and Healthcare Facilities" for labeling requirements, complying with NFPA 99, for medical, compressed-air system piping and associated components in healthcare facilities.
 - 2. Section 226213 "Vacuum Piping for Laboratory and Healthcare Facilities" for labeling requirements, complying with NFPA 99, for medical surgical, healthcare laboratory, and dental vacuum system piping, waste anesthetic gas and oral evacuation system piping, and associated components in healthcare facilities.

3.03 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment-Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Valve-numbering scheme.
- E. Valve Schedules: For each piping system. Include in operation and maintenance manuals.

PART 2 PRODUCTS

4.01 EQUIPMENT LABELS

- A. Metal Labels for Equipment:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Brady Corporation.
 - b. Champion America.
 - c. Kolbi Pipe Marker Co.
 - d. LEM Products Inc.
 - e. Marking Services, Inc.
 - f. Seton Identification Products; a Brady Corporation company.
 - 2. Material and Thickness: Brass, 0.032-inch minimum thickness, with predrilled or stamped holes for attachment hardware.

3. Letter and Background Color: As indicated for specific application under Part 3.
 4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (19.05 mm).
 5. Minimum Letter Size: 1/4 inch (6.35 mm) for name of units if viewing distance is less than 24 inches (609.6 mm), 1/2 inch (12.7 mm) for viewing distances of up to 72 inches (1828.8 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 6. Fasteners: Stainless steel rivets or self-tapping screws.
 7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Plastic Labels for Equipment:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Brady Corporation.
 - b. Champion America.
 - c. Kolbi Pipe Marker Co.
 - d. LEM Products Inc.
 - e. Marking Services, Inc.
 - f. Seton Identification Products; a Brady Corporation company.
 2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.18 mm) thick, with predrilled holes for attachment hardware.
 3. Letter and Background Color: As indicated for specific application under Part 3.
 4. Maximum Temperature: Able to withstand temperatures of up to 160 deg F.
 5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (19.05 mm).
 6. Minimum Letter Size: 1/4 inch (6.35 mm) for name of units if viewing distance is less than 24 inches (609.6 mm), 1/2 inch (12.7 mm) for viewing distances of up to 72 inches (1828.8 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 7. Fasteners: Stainless steel rivets or self-tapping screws.
 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

4.02 WARNING SIGNS AND LABELS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- a. Brady Corporation.
 - b. Champion America.
 - c. Kolbi Pipe Marker Co.
 - d. LEM Products Inc.
 - e. Marking Services, Inc.
 - f. Seton Identification Products; a Brady Corporation company.
- B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.18 mm) thick, with predrilled holes for attachment hardware.
- C. Letter and Background Color: As indicated for specific application under Part 3.
- D. Maximum Temperature: Able to withstand temperatures of up to 160 deg F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (19.05 mm).

- F. Minimum Letter Size: 1/4 inch (6.35 mm) for name of units if viewing distance is less than 24 inches (609.6 mm), 1/2 inch (12.7 mm) for viewing distances of up to 72 inches (1828.8 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- G. Fasteners: Stainless steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Arc-Flash Warning Signs: Provide arc-flash warning signs in locations and with content in accordance with requirements of OSHA and NFPA 70E, and other applicable codes and standards.
- J. Label Content: Include caution and warning information plus emergency notification instructions.

4.03 WARNING TAPE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Brady Corporation.
 - 2. Brimar Industries, Inc.
 - 3. Craftmark Pipe Markers.
 - 4. National Marker Company.
 - 5. Seton Identification Products; a Brady Corporation company.
- B. Material: Vinyl.
- C. Minimum Thickness: 0.005 inch (0.13 mm).
- D. Letter, Pattern, and Background Color: As indicated for specific application under Part 3.
- E. Waterproof Adhesive Backing: Suitable for indoor or outdoor use.
- F. Maximum Temperature: 160 deg F.
- G. Minimum Width: 4 inches (101.6 mm).

4.04 PIPE LABELS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Actioncraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.
 - 2. Brady Corporation.
 - 3. Brimar Industries, Inc.
 - 4. Carlton Industries, LP.
 - 5. Champion America.
 - 6. Craftmark Pipe Markers.
 - 7. emedco.
 - 8. Kolbi Pipe Marker Co.
 - 9. LEM Products Inc.
 - 10. Marking Services Inc.
 - 11. Seton Identification Products; a Brady Corporation company.
- B. General Requirements for Manufactured Pipe Labels: Preprinted, color coded, with lettering indicating service and showing flow direction in accordance with ASME A13.1.
- C. Letter and Background Color: As indicated for specific application under Part 3.
- D. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- E. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

- F. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings. Also include:
 - 1. Pipe size.
 - 2. Flow-Direction Arrows: Include flow-direction arrows on main distribution piping. Arrows may be either integral with label or applied separately.
 - 3. Lettering Size: Size letters in accordance with ASME A13.1 for piping. At least 1/2 inch (12.7 mm) for viewing distances of up to 72 inches (1828.8 mm) and proportionately larger lettering for greater viewing distances.

4.05 STENCILS

- A. Stencils for Piping:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Brimar Industries, Inc.
 - b. Craftmark Pipe Markers.
 - c. Kolbi Pipe Marker Co.
 - d. Marking Services Inc.
 - 2. Lettering Size: Size letters in accordance with ASME A13.1 for piping.
 - 3. Stencil Material: Aluminum, brass, or fiberboard.
 - 4. Stencil Paint: Exterior, gloss, acrylic enamel in colors complying with recommendations in ASME A13.1 unless otherwise indicated. Paint may be in pressurized spray-can form.
 - 5. Identification Paint: Exterior, acrylic enamel in colors in accordance with ASME A13.1 unless otherwise indicated. Paint may be in pressurized spray-can form.
 - 6. Letter and Background Color: As indicated for specific application under Part 3.

4.06 VALVE TAGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Actioncraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.
 - 2. Brady Corporation.
 - 3. Brimar Industries, Inc.
 - 4. Carlton Industries, LP.
 - 5. Champion America.
 - 6. Craftmark Pipe Markers.
 - 7. emedco.
 - 8. Kolbi Pipe Marker Co.
 - 9. LEM Products Inc.
 - 10. Marking Services Inc.
 - 11. Seton Identification Products; a Brady Corporation company.
- B. Description: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
 - 1. Tag Material: Brass, 0.04-inch minimum thickness, with predrilled or stamped holes for attachment hardware.
 - 2. Fasteners: Brass beaded chain or S-hook.
- C. Letter and Background Color: As indicated for specific application under Part 3.
- D. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
 - 1. Include valve-tag schedule in operation and maintenance data.

4.07 WARNING TAGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Brady Corporation.
 - 2. Brimar Industries, Inc.
 - 3. Champion America.
 - 4. Craftmark Pipe Markers.
 - 5. emedco.
 - 6. Kolbi Pipe Marker Co.
 - 7. LEM Products Inc.
 - 8. Marking Services Inc.
 - 9. Seton Identification Products; a Brady Corporation company.
- B. Description: Preprinted accident-prevention tags of plasticized card stock with matte finish suitable for writing.
 - 1. Size: Approximately 4 by 7 inches (177.8 mm).
 - 2. Fasteners: Brass grommet and wire.
 - 3. Nomenclature: Large-size primary caption, such as "DANGER," "CAUTION," or "DO NOT OPERATE."
 - 4. Letter and Background Color: As indicated for specific application under Part 3.

PART 3 EXECUTION

5.01 PREPARATION

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

5.02 INSTALLATION, GENERAL REQUIREMENTS

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.
- D. Locate identifying devices so that they are readily visible from the point of normal approach.

5.03 INSTALLATION OF EQUIPMENT LABELS, WARNING SIGNS, AND LABELS

- A. Permanently fasten labels on each item of plumbing equipment.
- B. Sign and Label Colors.
 - 1. White letters on an ANSI Z535.1 safety-green background.
- C. Locate equipment labels where accessible and visible.
- D. Arc-Flash Warning Signs: Provide arc-flash warning signs on electrical disconnects and other equipment where are-flash hazard exists, as indicated on Drawings, and in accordance with requirements of OSHA and NFPA 70E, and other applicable codes and standards.

5.04 INSTALLATION OF WARNING TAPE

- A. Warning Tape Color and Pattern: Yellow background with black diagonal stripes, marking pattern, text.
- B. Install warning tape on pipes and ducts, with cross-designated walkways providing less than 6 feet (182.88 cm) of clearance.
- C. Locate tape so as to be readily visible from the point of normal approach.

5.05 INSTALLATION OF PIPE LABELS

- A. Piping Color Coding: Painting of piping is specified in Section 099123 "Interior Painting."
- B. Install pipe labels showing service and flow direction with permanent adhesive on pipes.
- C. Stenciled Pipe Label Option: Stenciled labels showing service and flow direction may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying with ASME A13.1, with painted, color-coded bands or rectangles on each piping system.
 - 1. Identification Paint: Use for contrasting background.
 - 2. Stencil Paint: Use for pipe marking.
- D. Pipe-Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Within 3 feet (91.44 cm) of each valve and control device.
 - 2. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 3. Within 3 feet (91.44 cm) of equipment items and other points of origination and termination.
 - 4. Spaced at maximum intervals of 25 ft along each run. Reduce intervals to 10 feet (304.8 cm) ???Insert dimension??? in areas of congested piping and equipment.
- E. Do not apply plastic pipe labels or plastic tapes directly to bare pipes conveying fluids at temperatures of 125 deg F or higher. Where these pipes are to remain uninsulated, use a short section of insulation or use stenciled labels.
- F. Flow-Direction Flow Arrows: Use arrows, in compliance with ASME A13.1, to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.
- G. Pipe-Label Color Schedule:
 - 1. Low-Pressure Compressed-Air Piping: White letters on an ANSI Z535.1 safety-blue background.
 - 2. High-Pressure Compressed-Air Piping: White letters on an ANSI Z535.1 safety-blue background.
 - 3. Vacuum Piping: White letters on an ANSI Z535.1 Safety blue background.
 - 4. Domestic Cold-Water Piping: White letters on an ANSI Z535.1 safety-green background.
 - 5. Domestic Hot-Water Piping: White letters on an ANSI Z535.1 safety-green background.
 - 6. Domestic Hot-Water Return Piping White letters on an ANSI Z535.1 safety-green background.
 - 7. Sanitary Waste and Storm Drainage Piping: White letters on a black background.
 - 8. Non-potable Cold Water: Black letters on an ANSI Z535.1 safety-yellow background.
 - 9. Non-potable Hot Water: Black letters on an ANSI Z535.1-yellow background.
 - 10. Non-potable Hot-Water Recirculation: Black letters on an ANSI Z535.1 safety-yellow background.

5.06 INSTALLATION OF VALVE TAGS

- A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, faucets, convenience and lawn-watering hose connections, and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule in the operating and maintenance manual.
 - 1. Valve-Tag Colors:
 - a. For each piping system, use the same lettering and background coloring system on valve tags as used in the piping system labels and background.

5.07 INSTALLATION OF WARNING TAGS

- A. Warning Tag Color: Black letters on an ANSI Z535.1 safety-yellow background.
- B. Attach warning tags, with proper message, to equipment and other items where scheduled.

END OF SECTION

SECTION 22 05 93

TESTING, ADJUSTING, AND BALANCING FOR PLUMBING

PART 1 GENERAL

3.01 RELATED DOCUMENTS

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

3.02 SUMMARY

- A. Section Includes:
 - 1. TAB of domestic water system.
 - 2. TAB of plumbing equipment:
 - a. Domestic hot-water in-line circulation pumps.
 - b. Laboratory air compressors.
 - c. Laboratory vacuum pumps.
 - 3. Pipe-leakage test verification.
 - 4. Testing, adjusting, and balancing of existing plumbing systems and equipment.

3.03 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. NEBB: National Environmental Balancing Bureau.
- C. TAB: Testing, adjusting, and balancing.
- D. TABB: Testing, Adjusting, and Balancing Bureau.
- E. TAB Specialist: An independent entity meeting qualifications to perform TAB work.
- F. TDH: Total dynamic head.

3.04 REFERENCE STANDARDS

- A. NEBB (TAB) - Procedural Standard for Testing, Adjusting and Balancing of Environmental Systems; 2019, with Errata (2022).

3.05 PREINSTALLATION MEETINGS

- A. TAB Conference: Conduct a TAB conference at Project site ???Insert location??? after approval of the TAB strategies and procedures plan, to develop a mutual understanding of the details. Provide a minimum of 15 days' advance notice of scheduled meeting time and location.
 - 1. Minimum Agenda Items:
 - a. The Contract Documents examination report.
 - b. The TAB plan.
 - c. Needs for coordination and cooperation of trades and subcontractors.
 - d. Proposed procedures for documentation and communication flow.

3.06 INFORMATIONAL SUBMITTALS

- A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- B. Contract Documents Examination Report: Within 30 days of Contractor's Notice to Proceed, submit the Contract Documents review report, as specified in Part 3.
- C. Strategies and Procedures Plan: Within 30 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures, as specified in "Preparation" Article.
- D. System Readiness Checklists: Within 30 days of Contractor's Notice to Proceed, submit system readiness checklists, as specified in "Preparation" Article.

- E. Examination Report: Submit a summary report of the examination review required in "Examination" Article.
- F. Certified TAB reports.
- G. Sample report forms.
- H. Instrument calibration reports, to include the following:
 - 1. Instrument type and make.
 - 2. Serial number.
 - 3. Application.
 - 4. Dates of use.
 - 5. Dates of calibration.

3.07 QUALITY ASSURANCE

- A. TAB Specialists Qualifications, Certified by AABC:
 - 1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC.
 - 2. TAB Technician: Employee of the TAB specialist and certified by AABC.
- B. TAB Specialists Qualifications, Certified by NEBB:
 - 1. TAB Field Supervisor: Employee of the TAB specialist and certified by NEBB (TAB Technician: Employee of the TAB specialist and certified by NEBB.
- C. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."
- D. ASHRAE 111 Compliance: Requirements in ASHRAE 111 applicable to analogous domestic water system and plumbing equipment balancing.
- E. ASHRAE 188 Compliance: Comply with balancing and report requirements, Section 8.3 "Balancing."
- F. Code and Authorities Having Jurisdiction Compliance: TAB is required to comply with governing codes and requirements of authorities having jurisdiction.

3.08 FIELD CONDITIONS

- A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.
- B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION

5.01 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.
- B. Examine installed systems for balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, and balancing valves and fittings. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.
- C. Examine approved submittals for plumbing systems and equipment.
- D. Examine design data, including plumbing system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about plumbing system and equipment controls.
- E. Examine equipment performance data, including pump curves.

1. Relate performance data to Project conditions and requirements, including pump system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
 2. Calculate pump system-effect factors to reduce performance ratings of plumbing equipment when installed under conditions different from the conditions used to rate equipment performance. Compare results with the design data and installed conditions.
- F. Examine system and equipment installations, and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- G. Examine test reports specified in individual system and equipment Sections.
- H. Examine plumbing equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.
- I. Examine temporary and permanent strainers. Verify that temporary strainer screens used during system cleaning and flushing have been removed and permanent strainers are installed and clean.
- J. Examine control valves for proper installation for their intended function of isolating, throttling, diverting, or mixing fluid flows.
- K. Examine system pumps to ensure absence of entrained air in the suction piping.
- L. Examine operating safety interlocks and controls on plumbing equipment.
- M. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

5.02 PREPARATION

- A. Prepare a TAB plan that includes the following:
1. Equipment and systems to be tested.
 2. Strategies and step-by-step procedures for balancing the systems.
 3. Instrumentation to be used.
 4. Sample forms with specific identification for all equipment.
- B. Perform system-readiness checks of plumbing systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:
1. Domestic Water System:
 - a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed in accordance with applicable code and authority having jurisdiction.
 - b. Water heaters are installed and functioning.
 - c. Piping is complete and all points of outlet are installed.
 - d. Water treatment is complete.
 - e. Systems are flushed, filled, and air purged.
 - f. Strainers are clean.
 - g. Control valves are functioning in accordance with the sequence of operation.
 - h. Shutoff and balance valves are 100 percent open.
 - i. hot-water circulating pumps are operational and proper rotation is verified.
 - j. Pump gauge connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
 - k. Variable-frequency controllers' startup is complete and safeties are verified.
 - l. Suitable access to balancing devices and equipment is provided.
 2. Sanitary Sewage/Drainage System:

- a. Leakage and pressure tests on sanitary sewage/drainage systems have been completed in accordance with applicable code and authority having jurisdiction requirements.
- b. Piping is complete.
- c. Sanitary sewage pumps/drainage pumps are operational.
- d. Control valves are functioning in accordance with the sequence of operation.
- e. Shutoff valves are 100 percent open.
- f. Suitable access to equipment is provided.
- 3. Compressed-Air System:
 - a. Leakage and pressure tests on compressed air distribution system have been satisfactorily completed in accordance with Division 22 requirements.
 - b. Piping is complete and all points of outlet are installed.
 - c. Systems are flushed, filled, and air purged.
 - d. Strainers are clean.
 - e. Control valves are functioning in accordance with the sequence of operation.
 - f. Shutoff and balance valves are 100 percent open.
 - g. Compressors are operational and of proper rotation.
 - h. Gauge connections are installed directly at compressor inlet and outlet flanges prior to valves or strainers.
 - i. Variable-frequency controllers' startup is complete and safeties are verified.
 - j. Suitable access to balancing devices and equipment is provided.
- 4. Vacuum System:
 - a. Leakage and pressure tests on vacuum system have been satisfactorily completed in accordance with Division 22 requirements.
 - b. Piping is complete and all points of inlet are installed.
 - c. Systems are flushed, filled, and purged.
 - d. Strainers are clean.
 - e. Control valves are functioning in accordance with the sequence of operation.
 - f. Shutoff and balance valves are 100 percent open.
 - g. Vacuum pumps are operational and of proper rotation.
 - h. Gauge connections are installed directly at vacuum pump inlet and outlet flanges prior to valves or strainers.
 - i. Variable-frequency controllers' startup is complete and safeties are verified.
 - j. Suitable access to balancing devices and equipment is provided.

5.03 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system in accordance with the procedures contained in AABC's "National Standards for Total System Balance NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.
- B. Cut insulation, pipes, and equipment casings for installation of test probes to the minimum extent necessary for TAB procedures.
 - 1. Where holes for probes are required in piping or equipment, install pressure and temperature test plugs to seal systems.
 - 2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish in accordance with Section 220716 "Plumbing Equipment Insulation" and Section 220719 "Plumbing Piping Insulation."
- C. Mark equipment and balancing devices, including valve position indicators and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

5.04 GENERAL PROCEDURES FOR PLUMBING EQUIPMENT

- A. Test, adjust, and balance plumbing equipment indicated on Drawings, including, but not limited to, the following:
 - 1. Motors.
 - 2. Domestic water in-line pumps.
 - 3. Domestic water heaters.
 - 4. Air compressors.
 - 5. Vacuum pumps.

5.05 PROCEDURES FOR DOMESTIC WATER SYSTEMS

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

5.06 PROCEDURES FOR COMPRESSED-AIR SYSTEMS

- A. Prepare test reports for air compressors, and other equipment. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required equipment flow rates with system design flow rates.
- B. Prepare schematic diagrams of systems' Record drawings piping layouts.
- C. In addition to requirements in "Preparation" Article, prepare compressed-air systems for testing and balancing as follows:
 - 1. Check remotest point of outlet for adequate pressure.
 - 2. Check pressure-control valves for proper position.
 - 3. Locate start-stop and disconnect switches, electrical interlocks, and motor controllers.
 - 4. Verify that motor controllers are equipped with properly sized thermal protection.
- D. Measure and record upstream and downstream pressure of pressure-reducing valves.
- E. Check settings and operation of pressure-reducing valves. Record final settings.
- F. Check settings and operation of each safety valve. Record settings.

5.07 PROCEDURES FOR VACUUM SYSTEMS

- A. Prepare test reports for vacuum pumps and other equipment. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required equipment flow rates with system design flow rates.

- B. Prepare schematic diagrams of systems' Record drawings piping layouts.
- C. In addition to requirements in "Preparation" Article, prepare domestic water systems for testing and balancing as follows:
 - 1. Check remotest point of inlet for adequate vacuum.
 - 2. Locate start-stop and disconnect switches, electrical interlocks, and motor controllers.
 - 3. Verify that motor controllers are equipped with properly sized thermal protection.

5.08 PROCEDURES FOR DOMESTIC HOT-WATER CIRCULATING INLINE PUMP

- A. Balance system with manual or automatic balancing valves by setting at design flow.
 - 1. Measure flow in main and branch pipes.
 - 2. Adjust main and branch balance valves for design flow.
 - 3. Re-measure each main and branch after all have been adjusted.
- B. Adjust pump to deliver total design flow.
 - 1. Measure pump TDH as follows:
 - a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
 - b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
 - c. Convert pressure to head and correct for differences in gauge heights.
 - d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.
 - 2. Monitor motor performance during procedures, and do not operate motor in an overloaded condition.
 - 3. Mark final settings and verify that all memory stops have been set.
 - 4. Verify final system conditions as follows:
 - a. Re-measure and confirm that total flow is within design.
 - b. Re-measure final pumps' operating data, TDH, volts, amps, speed, and static profile.
 - c. Mark final settings.

5.09 PROCEDURES FOR MOTORS

- A. Motors ½ HP and Larger: Test at final balanced conditions and record the following data:
 - 1. Manufacturer's name, model number, and serial number.
 - 2. Motor horsepower rating.
 - 3. Motor rpm.
 - 4. Phase and hertz.
 - 5. Nameplate and measured voltage, each phase.
 - 6. Nameplate and measured amperage, each phase.
 - 7. Starter size and thermal-protection-element rating.
 - 8. Service factor and frame size.
- B. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation.

5.10 PROCEDURES FOR WATER HEATERS

- A. Electric Water Heaters:
 - 1. Measure and record entering- and leaving-water temperatures.
 - 2. Measure and record water flow.
 - 3. Measure and record pressure drop.
 - 4. Measure and Record relief valve(s) pressure setting.
 - 5. Capacity: Calculate in Btu/h (kW) of heating output.
 - 6. Efficiency: Calculate operating efficiency for comparison to submitted equipment.

5.11 TOLERANCES

- A. Set plumbing system's flow rates within the following tolerances:
 - 1. Domestic Water Flow Rate: Plus or minus 10 percent. If design value is less than 10 gpm (0.63 L/s), within 10 percent.
 - 2. Compressed-Air Flow Rate: [Plus 10 percent or minus 5 percent. If design value is less than 10 gpm within 10 percent.
 - 3. Vacuum Flow Rate: Plus 10 percent or minus 5 percent.

5.12 PROGRESS REPORTING

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for system-balancing devices. Recommend changes and additions to system-balancing devices, to facilitate proper performance measuring and balancing. Recommend changes and additions to plumbing systems and general construction to allow access for performance-measuring and -balancing devices.
- B. Status Reports: Prepare biweekly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

5.13 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
 - 1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
 - 2. Include a list of instruments used for procedures, along with proof of calibration.
 - 3. Certify validity and accuracy of field data.
- B. Final Report Contents: In addition to certified field-report data, include the following:
 - 1. Pump curves.
 - 2. Manufacturers' test data.
 - 3. Field test reports prepared by system and equipment installers.
 - 4. Other information relative to equipment performance; do not include Shop Drawings and Product Data.
- C. General Report Data: In addition to form titles and entries, include the following data:
 - 1. Title page.
 - 2. Name and address of the TAB specialist.
 - 3. Project name.
 - 4. Project location.
 - 5. Architect's name and address.
 - 6. Engineer's name and address.
 - 7. Contractor's name and address.
 - 8. Report date.
 - 9. Signature of TAB supervisor who certifies the report.
 - 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 - 11. Summary of contents, including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 - 12. Nomenclature sheets for each item of equipment.
 - 13. Notes to explain why certain final data in the body of reports vary from indicated values.

14. Test conditions for pump performance forms, including the following:
 - a. Variable-frequency controller settings for variable-flow hydronic systems.
 - b. Settings for pressure controller(s).
 - c. Other system operating conditions that affect performance.
- D. System Diagrams: Include schematic layouts of distribution systems. Present each system with single-line diagram and include the following:
 1. Flow rates.
 2. Pipe and valve sizes and locations.
 3. Balancing stations.
 4. Position of balancing devices.
- E. Electric Water Heater Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:
 1. Unit Data:
 - a. System identification.
 - b. Location.
 - c. Model number and unit size.
 - d. Manufacturer's serial number.
 - e. Output capacity in Btu/h (kW).
 - f. Number of stages.
 - g. Connected volts, phase, and hertz.
 - h. Rated amperage.
 2. Test Data (Indicated and Actual Values):
 - a. Heat output in Btu/h (kW).
 - b. Entering-water temperature in deg F.
 - c. Leaving-water temperature in deg F.
 - d. High-temperature-limit setting in deg F.
 - e. Operating set point in deg F.
 - f. Voltage at each connection.
 - g. Amperage for each phase.
- F. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves, and include the following:
 1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Service.
 - d. Make and size.
 - e. Model number and serial number.
 - f. Water flow rate in gpm (L/s).
 - g. Water-pressure differential in feet of head or psig (kPa).
 - h. Required net positive suction head in feet of head or psig (kPa).
 - i. Pump speed.
 - j. Impeller diameter in inches (mm).
 - k. Motor make and frame size.
 - l. Motor horsepower and rpm.
 - m. Voltage at each connection.
 - n. Amperage for each phase.
 - o. Full-load amperage and service factor.
 - p. Seal type.
 2. Test Data (Indicated and Actual Values):
 - a. Static head in feet of head or psig.

- b. Pump shutoff pressure in feet of head or psig.
 - c. Actual impeller size in inches.
 - d. Full-open flow rate in gpm.
 - e. Full-open pressure in feet of head or psig.
 - f. Final discharge pressure in feet of head or psig.
 - g. Final suction pressure in feet of head or psig.
 - h. Final total pressure in feet of head or psig.
 - i. Final water flow rate in gpm.
 - j. Voltage at each connection.
 - k. Amperage for each phase.
- G. Instrument Calibration Reports:
- 1. Report Data:
 - a. Instrument type and make.
 - b. Serial number.
 - c. Application.
 - d. Dates of use.
 - e. Dates of calibration.

5.14 VERIFICATION OF TAB REPORT

- A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of Construction Manager or Commissioning Authority.
- B. Construction Manager shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to the lesser of either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
- C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
- D. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the TAB shall be considered incomplete and shall be rejected.
- E. If recheck measurements find the number of failed measurements noncompliant with requirements indicated, proceed as follows:
 - 1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection. All changes shall be tracked to show changes made to previous report.
 - 2. If the second final inspection also fails, Owner may pursue other Contract options to complete TAB work.
- F. Prepare test and inspection reports.

5.15 ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

END OF SECTION

SECTION 22 07 19

PLUMBING PIPING INSULATION

PART 1 GENERAL

3.01 REFERENCE STANDARDS

- A. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement; 2007 (Reapproved 2024).
- B. ASTM C449 - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement; 2007 (Reapproved 2024).
- C. ASTM C450 - Standard Practice for Fabrication of Thermal Insulating Fitting Covers for NPS Piping, and Vessel Lagging; 2018 (Reapproved 2026).
- D. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2026.
- E. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation; 2025.
- F. ASTM C552 - Standard Specification for Cellular Glass 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 C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel; 2008 (Reapproved 2023).
- I. ASTM C1126 - Standard Specification for Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation; 2024.
- J. ASTM C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation; 2023.
- K. ASTM C1427 - Standard Specification for Extruded Preformed Flexible Cellular Polyolefin Thermal Insulation in Sheet and Tubular Form; 2025.
- L. ASTM D1784 - Standard Classification System and Basis for Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds; 2025.
- M. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026a.
- N. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2024a.
- O. ASTM F1249 - Standard Test Method for Water Vapor Transmission Rate Through Plastic Film and Sheeting Using a Modulated Infrared Sensor; 2025.
- P. ICC A117.1 - Accessible and Usable Buildings and Facilities; 2017.

3.02 RELATED DOCUMENTS

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

3.03 SUMMARY

- A. Section includes insulating the following plumbing piping services:
 - 1. Domestic cold-water piping.
 - 2. Domestic hot-water piping.
 - 3. Domestic recirculating hot-water piping.
 - 4. Sanitary waste piping exposed to freezing conditions.
 - 5. Storm-water piping exposed to freezing conditions.
 - 6. Roof drains and rainwater leaders.

7. Supplies and drains for handicap-accessible lavatories and sinks.

3.04 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).
- B. Sustainable Design Submittals:
- C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Detail attachment and covering of heat tracing inside insulation.
 - 3. Detail insulation application at pipe expansion joints for each type of insulation.
 - 4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 - 5. Detail removable insulation at piping specialties, equipment connections, and access panels.
 - 6. Detail application of field-applied jackets.
 - 7. Detail application at linkages of control devices.
- D. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use. Sample sizes are as follows:
 - 1. Preformed Pipe Insulation Materials: 12 inches (304.8 mm) long by NPS 2.
 - 2. Jacket Materials for Pipe: 12 inches (304.8 mm) long by NPS 2.
 - 3. Sheet Jacket Materials: 12 inches (304.8 mm) square.
 - 4. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

3.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
- C. Field quality-control reports.

3.06 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less and smoke-developed index of 150 or less.
- C. Mockups: 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 Architect. Use materials indicated for the completed Work.
 - 1. Piping Mockups:

- a. One 10-foot section of NPS 2 straight pipe.
 - b. One each of a 90 degree threaded, welded, and flanged elbow.
 - c. One each of a threaded, welded, and flanged tee fitting.
 - d. One NPS 2 or smaller valve and one NPS 2-1/2 or larger valve.
 - e. Four support hangers, including hanger shield and insert.
 - f. One threaded strainer and one flanged strainer with removable portion of insulation.
 - g. One threaded reducer and one welded reducer.
 - h. One pressure temperature tap.
 - i. One mechanical coupling.
 - j. One union.
2. For each mockup, fabricate cutaway sections to allow observation of application details for insulation materials, adhesives, mastics, attachments, and jackets.
 3. Notify Architect seven days in advance of dates and times when mockups will be constructed.
 4. Obtain Architect's approval of mockups before starting insulation application.
 5. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 7. Demolish and remove mockups when directed.
- D. Comply with the following applicable standards and other requirements specified for miscellaneous components:
1. Supply and Drain Protective Shielding Guards: ICC A117.1.

3.07 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

3.08 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

3.09 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 PRODUCTS

4.01 INSULATION MATERIALS

- A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

-
- C. Products that come into contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.
 - D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable in accordance with ASTM C795.
 - E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
 - F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Comply with ASTM C552.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Pittsburgh Corning Corporation.
 - 2. Preformed Pipe Insulation: Type II, Class 1, without jacket.
 - 3. Preformed Pipe Insulation: Type II, Class 2, with factory-applied ASJ jacket.
 - 4. Factory fabricate shapes in accordance with ASTM C450 and ASTM C585.
 - 5. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - G. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C534/C534M, Type I for tubular materials.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Aeroflex USA.
 - b. Armacell LLC.
 - c. K-Flex USA.
 - H. Mineral-Fiber, Preformed Pipe: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C547.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Johns Manville; a Berkshire Hathaway company.
 - b. Knauf Insulation.
 - c. Manson Insulation Inc.
 - d. Owens Corning.
 - 2. Preformed Pipe Insulation: Type I, Grade A with factory-applied ASJ.
 - 3. 850 deg F.
 - 4. Factory fabricate shapes in accordance with ASTM C450 and ASTM C585.
 - 5. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - I. Phenolic: Preformed pipe insulation of rigid, expanded, closed-cell structure. Comply with ASTM C1126.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ITW Insulation Systems; Illinois Tool Works, Inc.
 - b. Resolco Inc.
 - 2. Preformed Pipe Insulation: Type III with factory-applied ASJ.
 - 3. Factory fabricate shapes in accordance with ASTM C450 and ASTM C585.
 - 4. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - J. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C534/C534M or ASTM C1427, Type I, Grade 1, for tubular materials.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Armacell LLC.

4.02 INSULATING CEMENTS

- A. Mineral-Fiber Insulating Cement: Comply with ASTM C195.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Ramco Insulation, Inc.
- B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C196.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Ramco Insulation, Inc.
- C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C449.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Ramco Insulation, Inc.

4.03 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F (minus 73 to plus 93 deg C).
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Foster Brand; H. B. Fuller Construction Products.
- C. Flexible Elastomeric and Polyolefin Adhesive: Solvent-based adhesive.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Aeroflex USA.
 - b. Armacell LLC.
 - c. Foster Brand; H. B. Fuller Construction Products.
 - d. K-Flex USA.
 - 2. Flame-spread index shall be 25 or less and smoke-developed index shall be 50 or less as tested in accordance with ASTM E84.
 - 3. Wet Flash Point: Below 0 deg F.
 - 4. Service Temperature Range: 40 to 200 deg F.
 - 5. Color: Black.
- D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller Construction Products.
- E. Phenolic Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller Construction Products.
- F. ASJ Adhesive and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A, for bonding insulation jacket lap seams and joints.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller Construction Products.
 - c. Mon-Eco Industries, Inc.
- G. PVC Jacket Adhesive: Compatible with PVC jacket.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Dow Consumer Solutions.
 - b. Johns Manville; a Berkshire Hathaway company.
 - c. P.I.C. Plastics, Inc.
 - d. Speedline Corporation.

4.04 MASTICS AND COATINGS

- A. Materials shall be compatible with insulation materials, jackets, and substrates.
- B. Vapor-Retarder Mastic, Water Based: Suitable for indoor use on below-ambient services.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller Construction Products.
 - c. Knauf Insulation.
 - d. Vimasco Corporation.
 2. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
 3. Service Temperature Range: 0 to plus 180 deg F.
 4. Comply with MIL-PRF-19565C, Type II, for permeance requirements, with supplier listing on DOD QPD - Qualified Products Database.
 5. Color: White.
- C. Vapor-Retarder Mastic, Solvent Based, Indoor Use: Suitable for indoor use on below-ambient services.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller Construction Products.
 - c. Mon-Eco Industries, Inc.
 2. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
 3. Service Temperature Range: 0 to 180 deg F (Minus 18 to plus 82 deg C).
 4. Color: White.
- D. Vapor-Retarder Mastic, Solvent Based, Outdoor Use: Suitable for outdoor use on below-ambient services.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller Construction Products.
 2. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
 3. Service Temperature Range: Minus 50 to plus 220 deg F (Minus 46 to plus 104 deg C).
 4. Color: White.
- E. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.

- b. Foster Brand; H. B. Fuller Construction Products.
- c. Knauf Insulation.
- d. Mon-Eco Industries, Inc.
- e. Vimasco Corporation.
- 2. Water-Vapor Permeance: ASTM E96/E96M, greater than 1.0 perm at manufacturer's recommended dry film thickness.
- 3. Service Temperature Range: 0 to plus 180 deg F.
- 4. Color: White.

4.05 LAGGING ADHESIVES

- A. Adhesives shall comply with MIL-A-3316C, Class I, Grade A, and shall be compatible with insulation materials, jackets, and substrates.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller Construction Products.
 - c. Vimasco Corporation.
 - 2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
 - 3. Service Temperature Range: 20 to plus 180 deg F.
 - 4. Color: White.

4.06 SEALANTS

- A. Materials shall be as recommended by the insulation manufacturer and shall be compatible with insulation materials, jackets, and substrates.
- B. Joint Sealants:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller Construction Products.
 - c. Mon-Eco Industries, Inc.
 - d. Pittsburgh Corning Corporation.
 - 2. Permanently flexible, elastomeric sealant.
 - 3. Service Temperature Range: Minus 58 to plus 176 deg F.
 - 4. Color: White or gray.
- C. FSK and Metal Jacket Flashing Sealants:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller Construction Products.
 - c. Mon-Eco Industries, Inc.
 - 2. Fire- and water-resistant, flexible, elastomeric sealant.
 - 3. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
 - 4. Color: Aluminum.
- D. ASJ Flashing Sealants and PVC Jacket Flashing Sealants:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - 2. Fire- and water-resistant, flexible, elastomeric sealant.
 - 3. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
 - 4. Color: White.

4.07 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
 - 1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
 - 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
 - 3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.

4.08 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C1136, Type I, unless otherwise indicated.
- B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.
- C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Johns Manville; a Berkshire Hathaway company.
 - b. P.I.C. Plastics, Inc.
 - c. Proto Corporation.
 - d. Speedline Corporation.
 - 2. Adhesive: As recommended by jacket material manufacturer.
 - 3. Color: White.
 - 4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
 - a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.
- D. Metal Jacket:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ITW Insulation Systems; Illinois Tool Works, Inc.
 - b. RPR Products, Inc.
 - 2. Aluminum Jacket: Comply with ASTM B209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
 - a. [Factory cut and rolled to size.
 - b. Finish and thickness are indicated in field-applied jacket schedules.
 - c. Moisture Barrier for Indoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
 - d. Moisture Barrier for Outdoor Applications: 3-mil thick, heat-bonded polyethylene and kraft paper.
 - e. Factory-Fabricated Fitting Covers:
 - 1) Same material, finish, and thickness as jacket.
 - 2) Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - 3) Tee covers.
 - 4) Flange and union covers.
 - 5) End caps.
 - 6) Beveled collars.
 - 7) Valve covers.

- 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

4.09 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. 3M Industrial Adhesives and Tapes Division.
 - b. Avery Dennison Corporation, Specialty Tapes Division.
 - c. Ideal Tape Co., Inc., an American Biltrite Company.
 - d. Knauf Insulation.
 2. Width: 3 inches (76.2 mm).
 3. Thickness: 11.5 mils (0.2921 mm).
 4. Adhesion: 90 ounces force/inch in width.
 5. Elongation: 2 percent.
 6. Tensile Strength: 40 lbf/inch in width.
 7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. 3M Industrial Adhesives and Tapes Division.
 - b. Avery Dennison Corporation, Specialty Tapes Division.
 - c. Ideal Tape Co., Inc., an American Biltrite Company.
 - d. Knauf Insulation.
 2. Width: 3 inches (76.2 mm).
 3. Thickness: 6.5 mils (0.1651 mm).
 4. Adhesion: 90 ounces force/inch in width.
 5. Elongation: 2 percent.
 6. Tensile Strength: 40 lbf/inch in width.
 7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. 3M Industrial Adhesives and Tapes Division.
 - b. Ideal Tape Co., Inc., an American Biltrite Company.
 2. Width: 2 inches (50.8 mm)
 3. Thickness: 6 mils (0.1524 mm).
 4. Adhesion: 64 ounces force/inch in width.
 5. Elongation: 500 percent.
 6. Tensile Strength: 18 lbf/inch in width.
- D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. 3M Industrial Adhesives and Tapes Division.
 - b. Avery Dennison Corporation, Specialty Tapes Division.
 - c. Ideal Tape Co., Inc., an American Biltrite Company.
 - d. Knauf Insulation.

2. Width: 2 inches (50.8 mm).
3. Thickness: 3.7 mils (0.09398 mm).
4. Adhesion: 100 ounces force/inch in width.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch in width.

PART 3 EXECUTION

5.01 EXAMINATION

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

5.02 PREPARATION

- A. Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
 1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils 0 inch (0.13 mm) thick and an epoxy finish 5 mils (0.127 mm) thick if operating in a temperature range of between 140 and 300 deg F (60 and 149 deg C). Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
 2. Carbon Steel: Coat carbon steel operating at a service temperature of between 32 and 300 deg F (0 and 149 deg C) with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
- C. Coordinate insulation installation with the tradesman installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless steel surfaces, use demineralized water.

5.03 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and of thicknesses required for each item of pipe system, as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during storage, application, and finishing. Replace insulation materials that get wet.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.

- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends attached to structure with vapor-barrier mastic.
 - 3. Install insert materials and insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward-clinching staples along both edges of strip, spaced 4 inches (101.6 mm) o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward-clinching staples along edge at 4 inches (101.6 mm) o.c.
 - a. For below-ambient services, apply vapor-barrier mastic over staples.
 - 4. Cover joints and seams with tape, in accordance with insulation material manufacturer's written instructions, to maintain vapor seal.
 - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 25 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (101.6 mm) beyond damaged areas. Adhere, staple, and seal patches in similar fashion to butt joints.
- P. For above-ambient services, do not install insulation to the following:
 - 1. Vibration-control devices.
 - 2. Testing agency labels and stamps.
 - 3. Nameplates and data plates.
 - 4. Cleanouts.

5.04 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches (50.8 mm) below top of roof flashing.
 - 4. Seal jacket to roof flashing with flashing sealant.

- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches (50.8 mm).
 - 4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
 - 1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.
- F. Insulation Installation at Floor Penetrations:
 - 1. Pipe: Install insulation continuously through floor penetrations.
 - 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

5.05 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials, except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, Mechanical Couplings, and Unions:
 - 1. Install insulation over fittings, valves, strainers, flanges, mechanical couplings, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
 - 2. Insulate pipe elbows using preformed fitting insulation made from same material and density as that of adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 - 3. Insulate tee fittings with preformed fitting insulation of same material and thickness as that used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 - 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as that used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 - 5. Insulate strainers using preformed fitting insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers, so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.

6. Insulate flanges, mechanical couplings, and unions, using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Stencil or label the outside insulation jacket of each union with the word "union" matching size and color of pipe labels.
 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 8. For services not specified to receive a field-applied jacket, except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing, using PVC tape.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as that of adjoining pipe insulation.
 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union at least 2 times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless steel or aluminum bands. Select band material compatible with insulation and jacket.
 3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
 4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches (50.8 mm) over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
 5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

5.06 INSTALLATION OF CELLULAR-GLASS INSULATION

- A. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of insulation to pipe with wire or bands, and tighten bands without deforming insulation materials.
 2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
 3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward-clinched staples at 6 inches (152.4 mm) o.c.
 4. For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.
- B. Insulation Installation on Pipe Flanges:
1. Install preformed pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as that of pipe insulation.
 4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25.4 mm), and seal joints with flashing sealant.
- C. Insulation Installation on Pipe Fittings and Elbows:
1. Install preformed sections of same material as that of straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
 2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.
- D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed sections of cellular-glass insulation to valve body.
 2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 3. Install insulation to flanges as specified for flange insulation application.

5.07 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Flanges:
1. Install pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as that of pipe insulation.
 4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Pipe Fittings and Elbows:
1. Install mitered sections of pipe insulation.
 2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed valve covers manufactured of same material as that of pipe insulation when available.
 2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 3. Install insulation to flanges as specified for flange insulation application.
 4. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

5.08 INSTALLATION OF MINERAL-FIBER INSULATION

- A. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of preformed pipe insulation to pipe with wire or bands, and tighten bands without deforming insulation materials.
 2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
 3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches (152.4 mm) o.c.

4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.
- B. Insulation Installation on Pipe Flanges:
 1. Install preformed pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
 4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25.4 mm), and seal joints with flashing sealant.
- C. Insulation Installation on Pipe Fittings and Elbows:
 1. Install preformed sections of same material as that of straight segments of pipe insulation when available.
 2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.
- D. Insulation Installation on Valves and Pipe Specialties:
 1. Install preformed sections of same material as that of straight segments of pipe insulation when available.
 2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
 3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 4. Install insulation to flanges as specified for flange insulation application.

5.09 INSTALLATION OF PHENOLIC INSULATION

- A. General Installation Requirements:
 1. Secure single-layer insulation with stainless steel bands at 12-inch intervals, and tighten bands without deforming insulation materials.
 2. Install two-layer insulation with joints tightly butted and staggered at least 3 inches (76.2 mm). Secure inner layer with 0.062-inch wire spaced at 12-inch intervals. Secure outer layer with stainless steel bands at 12-inch intervals.
- B. Insulation Installation on Straight Pipes and Tubes:
 1. Secure each layer of insulation to pipe with wire or bands, and tighten bands without deforming insulation materials.
 2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
 3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward-clinched staples at 6 inches (152.4 mm) o.c.
 4. For insulation with factory-applied jackets with vapor retarders on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.
- C. Insulation Installation on Pipe Flanges:
 1. Install preformed pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as that of pipe insulation.

- D. Insulation Installation on Pipe Fittings and Elbows:
 - 1. Install preformed insulation sections of same material as that of straight segments of pipe insulation. Secure according to manufacturer's written instructions.
- E. Insulation Installation on Valves and Pipe Specialties:
 - 1. Install preformed insulation sections of same material as that of straight segments of pipe insulation. Secure according to manufacturer's written instructions.
 - 2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 - 3. Install insulation to flanges as specified for flange insulation application.

5.10 INSTALLATION OF POLYOLEFIN INSULATION

- A. Insulation Installation on Straight Pipes and Tubes:
 - 1. Seal split-tube longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Flanges:
 - 1. Install pipe insulation to outer diameter of pipe flange.
 - 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 - 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyolefin sheet insulation of same thickness as that of pipe insulation.
 - 4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Pipe Fittings and Elbows:
 - 1. Install mitered sections of polyolefin pipe insulation.
 - 2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Insulation Installation on Valves and Pipe Specialties:
 - 1. Install cut sections of polyolefin pipe and sheet insulation to valve body.
 - 2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 - 3. Install insulation to flanges as specified for flange insulation application.
 - 4. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

5.11 FIELD-APPLIED JACKET INSTALLATION

- A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
 - 1. Draw jacket smooth and tight to surface with 2-inch (50-mm) overlap at seams and joints.
 - 2. Embed glass cloth between two 0.062-inch- (1.6-mm-) thick coats of lagging adhesive.
 - 3. Completely encapsulate insulation with coating, leaving no exposed insulation.
- B. Where FSK jackets are indicated, install as follows:
 - 1. Draw jacket material smooth and tight.
 - 2. Install lap or joint strips with same material as jacket.
 - 3. Secure jacket to insulation with manufacturer's recommended adhesive.
 - 4. Install jacket with 1-1/2-inch (38-mm) laps at longitudinal seams and 3-inch- (75-mm-) wide joint strips at end joints.

5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
- C. Where PVC jackets are indicated, install with 1-inch (25-mm) overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.
 1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- D. Where metal jackets are indicated, install with 2-inch (50-mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless steel bands 12 inches (304.8 mm) o.c. and at end joints.

5.12 FINISHES

- A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."
 1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless steel jackets.

5.13 FIELD QUALITY CONTROL

- A. Owner will engage a qualified testing agency to perform tests and inspections.
- B. Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections with the assistance of a factory-authorized service representative.
- E. Tests and Inspections: Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two ???Insert number??? locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.
- F. All insulation applications will be considered defective if they do not pass tests and inspections.
- G. Prepare test and inspection reports.

5.14 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
 1. Drainage piping located in crawl spaces.
 2. Underground piping.
 3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

5.15 INDOOR PIPING INSULATION SCHEDULE

- A. Domestic Cold Water:
 - 1. NPS 1 and Smaller: Insulation shall be one of the following:
 - a. Cellular Glass: 1-1/2 inches (38 mm) thick.
 - b. Flexible Elastomeric: 1 inch (25.4 mm) thick.
 - c. Phenolic: 1 inch (25.4 mm) thick.
 - 2. NPS 1-1/4 and Larger: Insulation shall be one of the following:
 - a. Cellular Glass: 1-1/2 inches (38 mm) thick.
 - b. Flexible Elastomeric: 1 inch (25.4 mm) thick.
 - c. Phenolic: 1 inch (25.4 mm) thick.
- B. Domestic Hot and Recirculated Hot Water:
 - 1. NPS 1-1/4 and Smaller: Insulation shall be one of the following:
 - a. Cellular Glass: 1-1/2 inches (38 mm) thick.
 - b. Flexible Elastomeric: 1 inch (25.4 mm) thick.
 - 2. NPS 1-1/2 and Larger: Insulation shall be one of the following:
 - a. Cellular Glass: 1-1/2 inches (38 mm) thick.
 - b. Flexible Elastomeric: 1 inch (25.4 mm) thick.
- C. Stormwater and Overflow:
 - 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Cellular Glass: 1-1/2 inches (38 mm) thick.
 - b. Flexible Elastomeric: 1 inch (25.4 mm) thick.
- D. Roof Drain and Overflow Drain Bodies:
 - 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Cellular Glass: 1-1/2 inches (38 mm) thick.
 - b. Flexible Elastomeric: 1 inch (25.4 mm) thick.
 - c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25.4 mm) thick.
- E. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:
 - 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Flexible Elastomeric: 3/4 inch (19.05 mm) thick.
 - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25.4 mm) thick.
- F. Floor Drains, Traps, and Sanitary Drain Piping within 10 Feet (3 m) ???Insert distance??? of Drain Receiving Condensate and Equipment Drain Water below 60 Deg F (16 Deg C):
 - 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Cellular Glass: 1-1/2 inches (38 mm) thick.
 - b. Flexible Elastomeric: 1 inch (25.4 mm) thick.

5.16 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

- A. Domestic Water Piping:
 - 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Flexible Elastomeric: 2 inches (50.8 mm) thick.
 - b. Phenolic: 2 inches (50.8 mm) thick.
 - c. Polyolefin: 2 inches (50.8 mm) thick.

5.17 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, Concealed:

1. None.

D. Piping, Exposed:

1. Aluminum, Smooth 0.020 inch (0.51 mm) thick.

5.18 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed:

1. Aluminum, Smooth 0.024 thick.

2. Stainless Steel, Type 304 Smooth No. 2B Finish 0.024 inch (0.61 mm) thick.

D. Piping, Exposed:

1. Stainless Steel, Type 316, Smooth No. 2B Finish with Z-Shaped Locking Seam: [0.010 inch (0.25 mm) 0.024 inch (0.61 mm) thick.

END OF SECTION

SECTION 22 11 16

DOMESTIC WATER PIPING

PART 1 GENERAL

3.01 REFERENCE STANDARDS

- A. ASME B1.20.1 - Pipe Threads, General Purpose, Inch; 2013 (Reaffirmed 2018).
- B. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2021.
- C. ASME B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges; 2021.
- D. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2021.
- E. ASME B16.24 - Cast Copper Alloy Pipe Flanges, Flanged Fittings, and Valves: Classes 150, 300, 600, 900, 1500, and 2500; 2021.
- F. ASME B18.2.1 - Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series); 2012 (Reaffirmed 2021).
- G. ASME B31.9 - Building Services Piping; 2025.
- H. ASSE 1061 - Performance Requirements for Push-Fit Fittings; 2025.
- I. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings; 1999, with Editorial Revision (2022).
- J. ASTM A536 - Standard Specification for Ductile Iron Castings; 2024.
- K. ASTM A674 - Standard Practice for Polyethylene Encasement for Ductile Iron Pipe; 2022.
- L. ASTM B32 - Standard Specification for Solder Metal; 2020.
- M. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2022.
- N. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications; 2022.
- O. ASTM B813 - Standard Specification for Water Flushable Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube; 2024.
- P. ASTM B828 - Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings; 2023.
- Q. ASTM D2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems; 2020 (Reapproved 2024).
- R. ASTM D2846/D2846M - Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Hot- and Cold-Water Distribution Systems; 2024.
- S. 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 (Reapproved 2024).
- T. ASTM F402 - Standard Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings; 2026.
- U. ASTM F493 - Standard Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings; 2022 (Reapproved 2026).
- V. ASTM F656 - Standard Specification for Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) and Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings; 2025.
- W. ASTM F1807 - Standard Specification for Metal Insert Fittings Utilizing a Copper Crimp Ring, or Alternate Stainless Steel Clamps, for SDR9 Cross-Linked Polyethylene (PEX) Tubing and SDR9 Polyethylene of Raised Temperature (PE-RT) Tubing; 2026.

- X. 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; 2024.
- Y. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding; 2019.
- Z. AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Pipe Systems; 2018.
- AA. AWWA C110/A21.10 - Ductile-Iron and Gray-Iron Fittings; 2021.
- BB. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings; 2023.
- CC. AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast; 2023.
- DD. AWWA C153/A21.53 - Ductile-Iron Compact Fittings; 2025.
- EE. AWWA C219 - Bolted Sleeve-Type Couplings for Plain-End Pipe; 2023.
- FF. AWWA C600 - Installation of Ductile-Iron Mains and Their Appurtenances; 2023.
- GG. AWWA C606 - Grooved and Shouldered Joints; 2022.
- HH. AWWA C651 - Disinfecting Water Mains; 2023.
- II. AWWA C652 - Disinfection of Water-Storage Facilities; 2019.
- JJ. AWWA M41 - Ductile-Iron Pipe and Fittings; 2025.
- KK. NSF 14 - Plastics Piping System Components and Related Materials; 2025.
- LL. NSF 61 - Drinking Water System Components - Health Effects; 2025, with Addendum
- MM. NSF 372 - Drinking Water System Components - Lead Content; 2024.

3.02 RELATED DOCUMENTS

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

3.03 SUMMARY

- A. Section Includes:
 - 1. Copper tube and fittings.
 - 2. Ductile-iron pipe and fittings.
 - 3. Galvanized-steel pipe and fittings.
 - 4. Piping joining materials.
 - 5. Encasement for piping.
 - 6. Transition fittings.
 - 7. Dielectric fittings.

3.04 ACTION SUBMITTALS

- A. Product Data:
 - 1. Pipe and tube.
 - 2. Fittings.
 - 3. Joining materials.
 - 4. Transition fittings.
- B. Sustainable Design Submittals:

3.05 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Piping layout, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.
- B. System purging and disinfecting activities report.
- C. Field quality-control reports.

PART 2 PRODUCTS

4.01 PIPING MATERIALS

- A. Potable-water piping and components shall comply with NSF 14, NSF 61, and NSF 372. Include marking "NSF-pw" on piping.

4.02 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tube: ASTM B88, Type L.
- B. Annealed-Temper Copper Tube: ASTM B88, Type L.
- C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.
- D. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, pressure fittings.
- E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
- F. Cast Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.
- G. Wrought Copper Unions: ASME B16.22.
 - 1. Description: Tee formed in copper tube in accordance with ASTM F2014.
- H. Grooved, Mechanical-Joint, Copper Tube Appurtenances:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International.
 - b. Grinnell G-Fire by Johnson Controls Company.
 - c. Shurjoint-Apollo Piping Products USA Inc.
 - d. Victaulic Company.
 - 2. Grooved-End, Copper Fittings: ASTM B75 (ASTM B75M) copper tube or ASTM B584 bronze castings.
 - 3. Grooved-End-Tube Couplings: To fit copper-tube dimensions; rigid pattern unless otherwise indicated; gasketed fitting, EPDM-rubber gasket, UL classified per NSF 61 and NSF 372, and rated for minimum 180 deg F, for use with ferrous housing and steel bolts and nuts; 300 psig (2068.43 kPa) minimum CWP pressure rating.
- I. Copper Tube, Pressure-Seal-Joint Fittings:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - b. Elkhart Products Corporation.
 - c. Mueller Industries, Inc.
 - d. NIBCO INC.
 - e. Viega LLC.
 - 2. Fittings: Cast-brass, cast-bronze, or wrought-copper with EPDM O-ring seal in each end.
 - 3. Minimum 200-psig working-pressure rating at 250 deg F.
- J. Copper-Tube, Push-on-Joint Fittings:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - b. Elkhart Products Corporation.
 - c. NIBCO INC.
 - d. Victaulic Company.
 - 2. Description:
 - a. Cast-copper fitting complying with ASME B16.18 or wrought-copper fitting complying with ASME B16.22.

- b. Stainless steel teeth and EPDM-rubber, O-ring seal in each end instead of solder-joint ends.

4.03 DUCTILE-IRON PIPE AND FITTINGS

- A. Mechanical-Joint, Ductile-Iron Pipe:
 - 1. AWWA C151/A21.51, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
 - 2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
- B. Standard-Pattern, Mechanical-Joint Fittings:
 - 1. AWWA C110/A21.10, ductile or gray iron.
 - 2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
- C. Compact-Pattern, Mechanical-Joint Fittings:
 - 1. AWWA C153/A21.53, ductile iron.
 - 2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
- D. Push-on-Joint, Ductile-Iron Pipe:
 - 1. AWWA C151/A21.51.
 - 2. Push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.
- E. Standard-Pattern, Push-on-Joint Fittings:
 - 1. AWWA C110/A21.10, ductile or gray iron.
 - 2. Gaskets: AWWA C111/A21.11, rubber.
- F. Compact-Pattern, Push-on-Joint Fittings:
 - 1. AWWA C153/A21.53, ductile iron.
 - 2. Gaskets: AWWA C111/A21.11, rubber.
- G. Plain-End, Ductile-Iron Pipe: AWWA C151/A21.51.
- H. Appurtenances for Grooved-End, Ductile-Iron Pipe:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Shurjoint-Apollo Piping Products USA Inc.
 - b. Smith-Cooper International.
 - c. Star Pipe Products.
 - d. Victaulic Company.
 - 2. Fittings for Grooved-End, Ductile-Iron Pipe: ASTM A47/A47M, malleable-iron castings or ASTM A536, ductile-iron castings with dimensions that match pipe.
 - 3. Mechanical Couplings for Grooved-End, Ductile-Iron-Piping:
 - a. AWWA C606 for ductile-iron-pipe dimensions.
 - b. Ferrous housing sections.
 - c. EPDM-rubber gaskets suitable for hot and cold water.
 - d. Bolts and nuts.
 - e. Minimum Pressure Rating:
 - 1) NPS 14 to NPS 18: 250 psig (1723.69 kPa).

4.04 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials:
 - 1. AWWA C110/A21.10, rubber, flat face, 1/8 inch (3.18 mm) thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
 - 2. Full-face or ring type unless otherwise indicated.

- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- C. Solder Filler Metals: ASTM B32, lead-free alloys.
- D. Flux: ASTM B813, water flushable.
- E. Brazing Filler Metals: AWS A5.8M/A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.
- F. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F493.
- G. Solvent Cements for Joining PVC Piping: ASTM D2564. Include primer according to ASTM F656.
- H. Plastic, Pipe-Flange Gaskets, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

4.05 ENCASEMENT FOR PIPING

- A. Standard: ASTM A674 or AWWA C105/A21.5.
- B. Form: tube.
- C. Color: Black.

4.06 TRANSITION FITTINGS

- A. General Requirements:
 - 1. Same size as pipes to be joined.
 - 2. Pressure rating at least equal to pipes to be joined.
 - 3. End connections compatible with pipes to be joined.
- B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
- C. Sleeve-Type Transition Coupling: AWWA C219.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Cascade Waterworks Mfg. Co.
 - b. Dresser, Inc.
 - c. Ford Meter Box Company, Inc. (The).
 - d. Jay R. Smith Mfg Co; a division of Morris Group International.
 - e. JCM Industries, Inc.
 - f. Romac Industries, Inc.
 - g. Smith-Blair, Inc.
 - h. Viking Johnson.
- D. Plastic-to-Metal Transition Unions:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Aquatherm.
 - b. Colonial Engineering, Inc.
 - c. NIBCO INC.
 - d. Spears Manufacturing Company.
 - 2. Description:
 - a. PVC four-part union.
 - b. Brass or stainless steel threaded end.
 - c. Solvent-cement-joint plastic end.
 - d. Rubber O-ring.
 - e. Union nut.

4.07 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Unions:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. A.Y. McDonald Mfg. Co.
 - b. Capitol Manufacturing Company.
 - c. Central Plastics Company.
 - d. HART Industrial Unions, LLC.
 - e. Jomar Valve.
 - f. Matco-Norca.
 - g. WATTS.
 - h. Wilkins.
 - i. Zurn Industries, LLC.
 - 2. Standard: ASSE 1079.
 - 3. Pressure Rating: 150 psig (1034.21 kPa).
 - 4. End Connections: Solder-joint copper alloy and threaded ferrous.
- C. Dielectric Flanges:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Capitol Manufacturing Company.
 - b. Central Plastics Company.
 - c. Matco-Norca.
 - d. WATTS.
 - e. Wilkins.
 - f. Zurn Industries, LLC.
 - 2. Standard: ASSE 1079.
 - 3. Factory-fabricated, bolted, companion-flange assembly.
 - 4. Pressure Rating: 150 psig (1034.21 kPa).
 - 5. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

PART 3 EXECUTION

5.01 PIPING APPLICATIONS

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
- B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.
- C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.
- D. Under-building-slab, domestic water, building-service piping, NPS 3 and smaller], shall be one of the following:
 - 1. Annealed-temper copper tube, ASTM B88, Type L; wrought-copper, solder-joint fittings; and brazed pressure-sealed joints.
- E. Under-building-slab, domestic water, building-service piping, NPS 4 to NPS 8 and larger, shall be one of the following:
 - 1. Annealed-temper copper tube, ASTM B88, Type K; wrought-copper, solder-joint fittings; and brazed joints.

- 2. Mechanical-joint, ductile-iron pipe; standard-pattern, mechanical-joint fittings; and mechanical joints.
- F. Aboveground domestic water piping, NPS 2 and smaller, shall be the following:
 - 1. Drawn-temper copper tube, ASTM B88, Type cast- or wrought-copper, solder-joint fittings; and brazed joints.
- G. Aboveground domestic water piping, NPS 2-1/2 to NPS 4, shall be the following:
 - 1. Drawn-temper copper tube, ASTM B88, Type L cast or wrought-copper, solder-joint fittings; and soldered joints.
- H. Aboveground domestic water piping, NPS 5 to NPS 8 shall be the following:
 - 1. Galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.
 - 2. Stainless steel Schedule 10 pipe, grooved-joint fittings, and grooved joints.

5.02 EARTHWORK

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

5.03 INSTALLATION OF PIPING

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."
- C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.
- D. Install underground ductile-iron pipe in PE encasement according to ASTM A674 or AWWA C105/A21.5.
- E. Install valves according to the following:
 - 1. Section 220523.12 "Ball Valves for Plumbing Piping."
 - 2. Section 220523.13 "Butterfly Valves for Plumbing Piping."
 - 3. Section 220523.14 "Check Valves for Plumbing Piping."
 - 4. Section 220523.15 "Gate Valves for Plumbing Piping."
- F. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in Section 221119 "Domestic Water Piping Specialties."
- G. Install domestic water piping level without pitch and plumb.
- H. Rough-in domestic water piping for water-meter installation according to utility company's requirements.
- I. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- J. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- K. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- L. Install piping to permit valve servicing.
- M. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.

- N. Install piping free of sags and bends.
- O. Install fittings for changes in direction and branch connections.
- P. Install PEX tubing with loop at each change of direction of more than 90 degrees.
- Q. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- R. Install pressure gauges on suction and discharge piping for each plumbing pump and packaged booster pump. Comply with requirements for pressure gauges in Section 220519 "Meters and Gages for Plumbing Piping."
- S. Install thermostats in hot-water circulation piping. Comply with requirements for thermostats in Section 221123 "Domestic Water Pumps."
- T. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements for thermometers."
- U. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- V. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- W. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

5.04 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Braze Joints" chapter.
- E. Soldered Joints for Copper Tubing: Apply ASTM B813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B828 or CDA's "Copper Tube Handbook."
- F. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools and procedure recommended by pressure-seal-fitting manufacturer. Leave insertion marks on pipe after assembly.
- G. Push-on Joints for Copper Tubing: Clean end of tube. Measure insertion depth with manufacturer's depth gage. Join copper tube and push-on-joint fittings by inserting tube to measured depth.
- H. Extruded-Tee Connections: Form tee in copper tube according to ASTM F2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.
- I. Joint Construction for Grooved-End Copper Tubing: Make joints according to AWWA C606. Roll groove ends of tubes. Lubricate and install gasket over ends of tubes or tube and fitting. Install coupling housing sections over gasket with keys seated in tubing grooves. Install and tighten housing bolts.

- J. Joint Construction for Grooved-End, Ductile-Iron Piping: Make joints according to AWWA C606. Cut round-bottom grooves in ends of pipe at gasket-seat dimension required for specified (flexible or rigid) joint. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.
- K. Joint Construction for Grooved-End Steel Piping: Make joints according to AWWA C606. Square cut groove ends of pipe as specified. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.
- L. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.
- M. Joint Construction for Solvent-Cemented Plastic Piping: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.
 - 2. CPVC Piping: Join according to ASTM D2846/D2846M Appendix.
 - 3. PVC Piping: Join according to ASTM D2855.
- N. Joints for PEX Tubing, ASTM: Join according to ASTM F1807 for metal insert and copper crimp ring fittings and ASTM F1960 for cold expansion fittings and reinforcing rings.
- O. Joints for PEX Tubing, ASSE: Join according to ASSE 1061 for push-fit fittings.
- P. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

5.05 INSTALLATION OF TRANSITION FITTINGS

- A. Install transition couplings at joints of dissimilar piping.
- B. Transition Fittings in Underground Domestic Water Piping:
 - 1. Fittings for NPS 1-1/2 and Smaller: Fitting-type coupling.
 - 2. Fittings for NPS 2 and Larger: Sleeve-type coupling.
- C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plastic-to-metal transition fittings.

5.06 INSTALLATION OF DIELECTRIC FITTINGS

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.
- C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.

5.07 INSTALLATION OF HANGERS AND SUPPORTS

- A. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Comply with requirements for hangers, supports, and anchor devices in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
- C. Install hangers for copper, galvanized steel piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- D. Support horizontal piping within 12 inches (304.8 mm) of each fitting.
- E. Support vertical runs of copper piping to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

5.08 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.
- C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
- D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
 - 1. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
 - 2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
 - 3. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
 - 4. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

5.09 IDENTIFICATION

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

5.10 ADJUSTING

- A. Perform the following adjustments before operation:
 - 1. Close drain valves, hydrants, and hose bibbs.
 - 2. Open shutoff valves to fully open position.
 - 3. Open throttling valves to proper setting.
 - 4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
 - a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
 - b. Adjust calibrated balancing valves to flows indicated.
 - 5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
 - 6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
 - 7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
 - 8. Check plumbing specialties and verify proper settings, adjustments, and operation.

5.11 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Piping Inspections:
 - a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
 - b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
 - 1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
 - 2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.

-
- c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
 - d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
 - 2. Piping Tests:
 - a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
 - b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
 - c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - d. Cap and subject piping to static water pressure of 50 psig (344.74 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 - e. Hydrostatic testing and documentation of test results for polypropylene piping to be in accordance with the manufacturer's instructions and submitted to the manufacturer upon successful completion per warranty requirements.
 - f. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
 - g. Prepare reports for tests and for corrective action required.
 - B. Domestic water piping will be considered defective if it does not pass tests and inspections.
 - C. Prepare test and inspection reports.
- 5.12 CLEANING
- A. Clean and disinfect potable domestic water piping as follows:
 - 1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
 - 2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Fill and isolate system according to either of the following:
 - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm (50 mg/L) of chlorine. Isolate with valves and allow to stand for 24 hours.
 - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm (200 mg/L) of chlorine. Isolate and allow to stand for three hours.
 - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
 - d. Repeat procedures if biological examination shows contamination.
 - e. Submit water samples in sterile bottles to authorities having jurisdiction.
 - B. Clean non-potable domestic water piping as follows:
 - 1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
 - 2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.

- b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
- C. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.
- D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

END OF SECTION

SECTION 22 11 19

DOMESTIC WATER PIPING SPECIALTIES

PART 1 GENERAL

3.01 RELATED DOCUMENTS

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

3.02 SUMMARY

- A. Section Includes:
 - 1. Vacuum breakers.
 - 2. Backflow preventers.
 - 3. Water pressure-reducing valves.
 - 4. Automatic water shutoff valve systems.
 - 5. Balancing valves.
 - 6. Temperature-actuated, water mixing valves.
 - 7. Strainers for domestic water piping.
 - 8. Outlet boxes.
 - 9. Hose stations.
 - 10. Hose bibbs.
 - 11. Wall hydrants.
 - 12. Ground hydrants.
 - 13. Post hydrants.
 - 14. Roof hydrants.
 - 15. Drain valves.
 - 16. Water-hammer arresters.
 - 17. Trap-seal primer device.
 - 18. Trap-seal primer systems.
 - 19. Flexible connectors.
 - 20. Water meters.

3.03 DEFINITIONS

- A. AMI: Advanced Metering Infrastructure.
- B. AMR: Automatic Meter Reading.
- C. FKM: A family of fluoroelastomer materials defined by ASTM D1418.

3.04 REFERENCE STANDARDS

- A. ASME A112.18.1 - Plumbing Supply Fittings; 2024.
- B. ASME B1.20.7 - Hose Coupling Screw Threads (Inch); 1991 (Reaffirmed 2024).
- C. ASSE 1001 - Performance Requirements for Atmospheric Type Vacuum Breakers; 2021.
- D. ASSE 1010 - Performance Requirements for Water Hammer Arresters; 2025.
- E. ASSE 1011 - Performance Requirements for Hose Connection Vacuum Breakers; 2023.
- F. ASSE 1012 - Performance Requirements for Backflow Preventers with an Intermediate Atmospheric Vent; 2021.
- G. ASSE 1013 - Performance Requirements for Reduced Pressure Principle Backflow Prevention Assemblies; 2021.
- H. ASSE 1016 - Performance Requirements for Automatic Compensating Valves for Individual Showers and Tub/Shower Combinations; 2017 (Reaffirmed 2021).

- I. ASSE 1017 - Performance Requirements for Temperature Actuated Mixing Valves for Hot Water Distribution Systems; 2023.
- J. ASSE 1018 - Performance Requirements for Trap Seal Primer Valves - Potable Water Supplied; 2023.
- K. ASSE 1052 - Performance Requirements for Hose Connection Backflow Preventers; 2023.
- L. ASSE 1070 - Performance Requirements for Water Temperature Limiting Devices; 2020.
- M. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings; 2017 (Reapproved 2025).
- N. AWWA C550 - Protective Interior Coatings for Valves and Hydrants; 2024.
- O. MSS SP-80 - Bronze Gate, Globe, Angle, and Check Valves; 2019.
- P. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; 2010, with Errata .
- Q. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.
- R. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- S. NSF 61 - Drinking Water System Components - Health Effects; 2025, with Addendum
- T. NSF 372 - Drinking Water System Components - Lead Content; 2024.
- U. PDI-WH 201 - Water Hammer Arresters; 2017.

3.05 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For domestic water piping specialties.
 - 1. Include diagrams for power, signal, and control wiring.

3.06 INFORMATIONAL SUBMITTALS

- A. Test and inspection reports.
- B. Field quality-control reports.

3.07 CLOSEOUT SUBMITTALS

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

PART 2 PRODUCTS

4.01 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

- A. Domestic water piping specialties intended to convey or dispense water for human consumption are to comply with the SDWA, requirements of authorities having jurisdiction, and NSF 61 and NSF 372, or to be certified in compliance with NSF 61 and NSF 372 by an American National Standards Institute (ANSI)-accredited third-party certification body that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

4.02 PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig (861.84 kPa) unless otherwise indicated.

4.03 VACUUM BREAKERS

- A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; a part of Aalberts Integrated Piping Systems.

-
- b. Cash Acme, A Division of Reliance Worldwide Corporation.
 - c. FEBCO; A WATTS Brand.
 - d. WATTS.
 - e. Zurn Industries, LLC.
 - 2. Standard: ASSE 1001.
 - 3. Size: NPS 1/4 to NPS 3, as required to match connected piping.
 - 4. Body: Bronze.
 - 5. Inlet and Outlet Connections: Threaded.
 - 6. Finish: Rough bronze.
- B. Hose-Connection Vacuum Breakers:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - b. Cash Acme, A Division of Reliance Worldwide Corporation.
 - c. Champion - Arrowhead.
 - d. Legend Valve & Fitting, Inc.
 - e. MIFAB, Inc.
 - f. WATTS.
 - g. Woodford Manufacturing Company.
 - h. Zurn Industries, LLC.
 - 2. Standard: ASSE 1011.
 - 3. Body: Bronze, nonremovable, with manual drain.
 - 4. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
 - 5. Finish: Rough bronze.

4.04 BACKFLOW PREVENTERS

- A. Intermediate Atmospheric-Vent Backflow Preventers:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - b. Cash Acme, A Division of Reliance Worldwide Corporation.
 - c. Legend Valve & Fitting, Inc.
 - d. WATTS.
 - e. Zurn Industries, LLC.
 - 2. Standard: ASSE 1012.
 - 3. Operation: Continuous-pressure applications.
 - 4. Size: NPS 1/2 and NPS 3/4.
 - 5. Body: Bronze.
 - 6. End Connections: Union, joint.
 - 7. Finish: Rough bronze.
- B. Reduced-Pressure-Principle Backflow Preventers:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ames Fire & Waterworks; A WATTS Brand.
 - b. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - c. FEBCO; A WATTS Brand.
 - d. WATTS.
 - e. Zurn Industries, LLC.
 - 2. Standard: ASSE 1013.
 - 3. Operation: Continuous-pressure applications.

4. Pressure Loss: 12 psig (82.74 kPa) maximum, through middle third of flow range.
 5. Size: NPS 4 and NPS 6
 6. Body: stainless steel] for NPS 2 and smaller; ductile or cast iron with interior lining that complies with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.
 7. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 (DN 65) and larger.
 8. Accessories:
 - a. Valves NPS 2 and Smaller: Ball type with threaded ends on inlet and outlet.
 - b. Valves NPS 2-1/2 and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.
 - c. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.
- C. Hose-Connection Backflow Preventers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - b. WATTS.
 - c. Woodford Manufacturing Company.
 - d. Zurn Industries, LLC.
 2. Standard: ASSE 1052.
 3. Operation: Up to 10-foot head of water back pressure.
 4. Inlet Size: NPS 3/4.
 5. Outlet Size: Garden-hose thread complying with ASME B1.20.7.
 6. Capacity: At least 3-gpm flow.

4.05 BALANCING VALVES

- A. Copper-Alloy Calibrated Balancing Valves
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Bell & Gossett; a Xylem brand.
 - b. IMI Hydronic Engineering Inc.
 - c. Nexus Valve, Inc.
 - d. NIBCO INC.
 - e. WATTS.
 2. Type: Ball or Y-pattern globe valve with two readout ports and memory-setting indicator.
 3. Body: bronze.
 4. Size: Same as connected piping, but not larger than NPS .
 5. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

4.06 TEMPERATURE-ACTUATED, WATER MIXING VALVES

- A. Water-Temperature Limiting Devices:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acorn Engineering Company; a Division of Morris Group International.
 - b. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - c. Cash Acme, A Division of Reliance Worldwide Corporation.
 - d. Leonard Valve Company.
 - e. POWERS; A WATTS Brand.
 - f. Symmons Industries, Inc.
 - g. TACO Comfort Solutions, Inc.
 - h. WATTS.
 - i. Zurn Industries, LLC.

-
2. Standard: ASSE 1070.
 3. Pressure Rating: 125 psig (861.84 kPa).
 4. Type: Thermostatically controlled, water mixing valve.
 5. Material: Bronze body with corrosion-resistant interior components.
 6. Connections: Threaded union inlets and outlet.
 7. Accessories: Check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
 8. Tempered-Water Setting: 110 deg F.
 9. Valve Finish: Rough bronze.
- B. Primary, Thermostatic, Water Mixing Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acorn Engineering Company; a Division of Morris Group International.
 - b. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - c. Cash Acme, A Division of Reliance Worldwide Corporation.
 - d. Lawler Manufacturing Company, Inc.
 - e. Leonard Valve Company.
 - f. POWERS; A WATTS Brand.
 - g. Symmons Industries, Inc.
 - h. WATTS.
 - i. Zurn Industries, LLC.
 2. Standard: ASSE 1017.
 3. Pressure Rating: 125 psig (861.84 kPa) minimum unless otherwise indicated.
 4. Type: Exposed-mounted, thermostatically controlled, water mixing valve.
 5. Material: Bronze body with corrosion-resistant interior components.
 6. Connections: Threaded inlets and outlet.
 7. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
 8. Tempered-Water Setting: 110 deg F.
 9. Tempered-Water Design Flow Rate: ???Insert gpm (L/s)???
 10. Valve Finish: Rough bronze.
 11. Piping Finish: Copper.
 12. Cabinet: Factory fabricated, stainless steel, for recessed mounting and with hinged, stainless steel door.
- C. Individual-Fixture, Water Tempering Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acorn Engineering Company; a Division of Morris Group International.
 - b. Lawler Manufacturing Company, Inc.
 - c. Leonard Valve Company.
 - d. POWERS; A WATTS Brand.
 - e. Zurn Industries, LLC.
 2. Standard: ASSE 1016, thermostatically controlled, water tempering valve.
 3. Pressure Rating: 125 psig (861.84 kPa) minimum unless otherwise indicated.
 4. Material: Bronze body with corrosion-resistant interior components.
 5. Temperature Control: Adjustable.
 6. Connections: Threaded inlets and outlet.
 7. Finish: Chrome plated.
 8. Tempered-Water Setting: 105 deg F .

4.07 STRAINERS FOR DOMESTIC WATER PIPING

- A. Y-Pattern Strainers ???Insert drawing designation if any???:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Keckley Company.
 - b. Titan Flow Control, Inc.
 - c. WATTS.
 - d. Zurn Industries, LLC.
 2. Pressure Rating: 125 psig (861.84 kPa) minimum unless otherwise indicated.
 3. Body: Bronze for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved, epoxy coated and for NPS 2-1/2 and larger.
 4. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
 5. Screen: Stainless steel with round perforations unless otherwise indicated.
 6. Perforation Size:
 - a. Strainers NPS 2 and Smaller: 0.033 inch (0.84 mm).
 - b. Strainers NPS 2-1/2 to NPS 6: 0.062 inch (1.57 mm).
 7. Drain: Factory-installed, hose-end drain valve.

4.08 OUTLET BOXES

- A. Clothes Washer Outlet Boxes:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acorn Engineering Company; a Division of Morris Group International.
 - b. Guy Gray, IPS Corporation.
 - c. LSP Products Group.
 - d. Oatey.
 - e. Sioux Chief Manufacturing Company, Inc.
 - f. Symmons Industries, Inc.
 - g. Water-Tite, IPS Corporation.
 2. Mounting: Recessed. Fire rated.
 3. Material and Finish: Enameled-steel, epoxy-painted-steel, or plastic box and faceplate.
 4. Faucet: Combination valved fitting or separate hot- and cold-water valved fittings complying with ASME A112.18.1. Include garden-hose thread complying with ASME B1.20.7 on outlets.
 5. Drain Outlet Connection: NPS 2.
 6. Accessory: Water hammer arresters.
 7. Supply Shutoff Fittings: NPS 1/2 ball valves and NPS 1/2 (copper, water tubing).
 8. Drain: NPS 2 standpipe and P-trap for direct waste connection to drainage piping.
- B. Icemaker Outlet Boxes:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Guy Gray, IPS Corporation.
 - b. LSP Products Group.
 - c. Oatey.
 - d. Sioux Chief Manufacturing Company, Inc.
 - e. Water-Tite, IPS Corporation.
 2. Mounting: Recessed. Fire rated if required.
 3. Material and Finish: Enameled-steel, epoxy-painted-steel, or plastic box and faceplate.
 4. Faucet: Valved fitting complying with ASME A112.18.1. Include NPS 1/2 or smaller copper tube outlet.

5. Accessory: Water hammer arrestor.
6. Supply Shutoff Fitting: NPS 1/2 (DN 15) gate, globe, or ball valve and NPS 1/2 copper, water tubing.

4.09 HOSE BIBBS

A. Hose Bibbs:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Jay R. Smith Mfg Co; a division of Morris Group International.
 - b. MIFAB, Inc.
 - c. Prier Products, Inc.
 - d. WATTS.
 - e. Woodford Manufacturing Company.
 - f. Zurn Industries, LLC.
2. Standard: ASME A112.18.1 for sediment faucets.
3. Body Material: Bronze.
4. Seat: Bronze, replaceable.
5. Supply Connections: NPS 1/2 or NPS 3/4 threaded or solder-joint inlet.
6. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
7. Pressure Rating: 125 psig (861.84 kPa).
8. Vacuum Breaker: Integral nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
9. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
10. Finish for Service Areas: Rough bronze.
11. Finish for Finished Rooms: Chrome or nickel plated.
12. Operation for Equipment Rooms: Wheel handle or operating key.
13. Operation for Service Areas: Operating key.
14. Operation for Finished Rooms: Operating key.
15. Include operating key with each operating-key hose bibb.
16. Include integral wall flange with each chrome- or nickel-plated hose bibb.

4.10 WALL HYDRANTS

A. Non-freeze Wall Hydrants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Jay R. Smith Mfg Co; a division of Morris Group International.
 - b. Josam Company.
 - c. MIFAB, Inc.
 - d. Prier Products, Inc.
 - e. WATTS.
 - f. Woodford Manufacturing Company.
 - g. Zurn Industries, LLC.
2. Standard: ASME A112.21.3M for concealed-outlet, self-draining wall hydrants.
3. Pressure Rating: 125 psig (861.84 kPa)
4. Operation: Loose key.
5. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
6. Inlet: NPS 3/4 or NPS 1.
7. Outlet, Concealed: With integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
8. Box: Deep, flush mounted with cover.
9. Box and Cover Finish: Polished nickel bronze.

10. Outlet, Exposed: With integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
11. Nozzle and Wall-Plate Finish: Chrome plated.
12. Operating Keys(s): One with each wall hydrant.

4.11 DRAIN VALVES

- A. Ball-Valve-Type, Hose-End Drain Valves:
 1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
 2. Pressure Rating: 400-psig minimum CWP.
 3. Size: NPS 3/4.
 4. Body: Copper alloy.
 5. Ball: Chrome-plated brass.
 6. Seats and Seals: Replaceable.
 7. Handle: Vinyl-covered steel.
 8. Inlet: Threaded or solder joint.
 9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.
- B. Gate-Valve-Type, Hose-End Drain Valves:
 1. Standard: MSS SP-80 for gate valves.
 2. Pressure Rating: Class 125.
 3. Size: NPS 3/4 .
 4. Body: ASTM B62 bronze.
 5. Inlet: NPS 3/4 threaded or solder joint.
 6. Outlet: Garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

4.12 WATER-HAMMER ARRESTERS

- A. Water-Hammer Arresters:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AMTROL, Inc.
 - b. Jay R. Smith Mfg Co; a division of Morris Group International.
 - c. Josam Company.
 - d. MIFAB, Inc.
 - e. Precision Plumbing Products.
 - f. Sioux Chief Manufacturing Company, Inc.
 - g. WATTS.
 - h. Zurn Industries, LLC.
 2. Standard: ASSE 1010 or PDI-WH 201.
 3. Type: Metal bellows.
 4. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

4.13 TRAP-SEAL PRIMER DEVICE

- A. Supply-Type, Trap-Seal Primer Device:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Jay R. Smith Mfg Co; a division of Morris Group International.
 - b. Josam Company.
 - c. MIFAB, Inc.
 - d. Precision Plumbing Products.
 - e. Sioux Chief Manufacturing Company, Inc.
 - f. WATTS.

- g. Zurn Industries, LLC.
2. Standard: ASSE 1018.
3. Pressure Rating: 125 psig (861.84 kPa) minimum.
4. Body: Bronze.
5. Inlet and Outlet Connections: NPS 1/2 threaded, union, or solder joint.
6. Gravity Drain Outlet Connection: NPS 1/2 threaded or solder joint.
7. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

4.14 FLEXIBLE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Flex-Hose Co., Inc.
 2. Mason Industries, Inc.
 3. Metraflex Company (The).
- B. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
 1. Working-Pressure Rating: Minimum 200 psig (1378.95 kPa).
 2. End Connections NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.
 3. End Connections NPS 2-1/2 and Larger: Flanged copper alloy.

PART 3 EXECUTION

5.01 INSTALLATION OF PIPING SPECIALTIES

- A. Backflow Preventers: Install in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
 1. Locate backflow preventers in same room as connected equipment or system.
 2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.
 3. Do not install bypass piping around backflow preventers.
- B. Water Regulators: Install with inlet and outlet shutoff valves and bypass with memory-stop balancing valve. Install pressure gauges on inlet and outlet.
- C. Outlet Boxes: Install boxes recessed in wall or surface mounted on wall. Install 1-1/2-by-3-1/2-inch fire-retardant-treated-wood blocking, wall reinforcement between studs. Comply with requirements for fire-retardant-treated-wood blocking in Section 061000 "Rough Carpentry."
- D. Hose Stations: Install with check stops or shutoff valves on inlets and with thermometer on outlet.
 1. Install cabinet-type units recessed in or surface mounted on wall as specified. Install 1-1/2-by-3-1/2-inch fire-retardant-treated-wood blocking, wall reinforcement between studs. Comply with requirements for fire-retardant-treated-wood blocking in Section 061000 "Rough Carpentry."
- E. Water-Hammer Arresters: Install in water piping in accordance with PDI-WH 201.
- F. Supply-Type, Trap-Seal Primer Device: Install with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.
- G. Drainage-Type, Trap-Seal Primer Device: Install as lavatory trap with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.

- H. Trap-Seal Primer Systems: Install with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust system for proper flow.

5.02 PIPING CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. When installing piping specialties adjacent to equipment and machines, allow space for service and maintenance.

5.03 ELECTRICAL CONNECTIONS

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

5.04 CONTROL CONNECTIONS

- A. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

5.05 IDENTIFICATION

- A. Plastic Labels for Equipment: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
 - 1. Vacuum breakers.
 - 2. Backflow preventers.
 - 3. Water pressure-reducing valves.
 - 4. Automatic water shutoff valve systems.
 - 5. Balancing valves.
 - 6. Temperature-actuated, water mixing valves.
 - 7. Outlet boxes.
 - 8. Hose stations.
 - 9. Wall hydrants.
 - 10. Ground hydrants.
 - 11. Post hydrants.
 - 12. Roof hydrants.
 - 13. Trap-seal primer device.
 - 14. Trap-seal primer systems.
 - 15. Water meters.
- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

5.06 ADJUSTING

- A. Set field-adjustable pressure set points of water pressure-reducing valves.
- B. Set field-adjustable flow set points of balancing valves.
- C. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.

5.07 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform the following tests and inspections with the assistance of a factory-authorized service representative.
 - 1. Test each reduced-pressure-principle backflow preventer and double-check, detector-assembly backflow preventer according to authorities having jurisdiction and the device's reference standard.
 - 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm unit operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

END OF SECTION

SECTION 22 11 23.21

INLINE, DOMESTIC WATER PUMPS

PART 1 GENERAL

3.01 REFERENCE STANDARDS

- A. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- B. NSF 61 - Drinking Water System Components - Health Effects; 2025, with Addendum
- C. NSF 372 - Drinking Water System Components - Lead Content; 2024.
- D. UL 778 - Standard for Motor-Operated Water Pumps; Current Edition, Including All Revisions.

3.02 RELATED DOCUMENTS

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

3.03 SUMMARY

- A. Section Includes:
 - 1. In-line, seal-less centrifugal pumps.
 - 2. Vertically mounted, in-line, close-coupled centrifugal pumps.

3.04 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include construction materials, rated capacities, certified performance curves with operating points plotted on curves, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Sustainable Design Submittals:

3.05 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Detail pumps and adjacent equipment. Show support locations, type of support, weight on each support, required clearances, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Structural members to which pumps will be attached.
 - 2. Size and location of initial access modules for acoustical tile.
- B. Seismic Qualification Data: Certificates, for inline, domestic-water pumps, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Field quality-control reports.

3.06 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For inline, domestic-water pumps to include in operation and maintenance manuals.

3.07 DELIVERY, STORAGE, AND HANDLING

- A. Retain shipping flange protective covers and protective coatings during storage.
- B. Protect bearings and couplings against damage.

- C. Comply with pump manufacturer's written instructions for handling.

PART 2 PRODUCTS

4.01 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. UL Compliance: UL 778 for motor-operated water pumps.
- C. Drinking Water System Components - Health Effects and Drinking Water System Components - Lead Content Compliance: NSF 61 and NSF 372.

4.02 IN-LINE, SEALLESS CENTRIFUGAL PUMPS

- A. Description: Factory-assembled and -tested, in-line, close-coupled, canned-motor, sealless, overhung-impeller centrifugal pumps.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Flo Fab Inc.
 - 2. Grundfos Pumps Corp.
 - 3. TACO Comfort Solutions, Inc.
 - 4. WILO USA LLC - WILO Canada Inc.
- C. Pump Construction:
 - 1. Pump and Motor Assembly: Hermetically sealed, replaceable-cartridge type with motor and impeller on common shaft and designed for installation with pump and motor shaft horizontal.
 - 2. Minimum Working Pressure: 125 psig (861.84 kPa).
 - 3. Maximum Continuous Operating Temperature: 220 deg F.
 - 4. Casing: Bronze, with threaded or companion-flange connections.
 - 5. Impeller: stainless steel.
 - 6. Motor: Single speed.

4.03 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 220513 "Common Motor Requirements for Plumbing Equipment."
 - 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

4.04 CONTROLS

- A. Thermostats: Electric; adjustable for control of hot-water circulation pump.
 - 1. Type: Water-immersion temperature sensor, for installation in piping.
 - 2. Range: 65 to 200 deg F temperature range.
 - 3. Enclosure: NEMA 250, Type 4X.
 - 4. Operation of Pump: On or off.
 - 5. Transformer: Provide if required.
 - 6. Power Requirement: 120 V ac.
 - 7. Settings: Start pump at 105 deg F and stop pump at 125 deg.
- B. Timers: Electric, for control of hot-water circulation pump.
 - 1. Type: Programmable, seven-day clock with manual override on-off switch.
 - 2. Enclosure: NEMA 250, Type 1, suitable for wall mounting.
 - 3. Operation of Pump: On or off.
 - 4. Transformer: Provide if required.
 - 5. Power Requirement: 120 V ac.

6. Programmable Sequence of Operation: Up to two on-off cycles each day for seven days operational sequence.

PART 3 EXECUTION

5.01 EXAMINATION

- A. Examine roughing-in for domestic-water-piping system to verify actual locations of piping connections before pump installation.

5.02 PUMP INSTALLATION

- A. Comply with HI 1.4.
- B. Mount pumps in orientation complying with manufacturer's written instructions.
- C. Pump Mounting:
 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
 2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 4. Install anchor bolts to elevations required for proper attachment to supported equipment.
- D. Install continuous-thread hanger rods and vibration isolation of size required to support pump weight.
 1. Comply with requirements for hangers and supports specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
- E. Install pressure switches in water-supply piping.
- F. Install thermostats in hot-water return piping.
- G. Install timers on wall next to the pump.
- H. Install time-delay relays in piping between water heaters and hot-water storage tanks.

5.03 PIPING CONNECTIONS

- A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to inline, domestic-water pumps, allow space for service and maintenance.
- C. Connect domestic-water piping to pumps. Install suction and discharge piping equal to or greater than size of pump nozzles.
 1. Install flexible connectors adjacent to pumps in suction and discharge piping of the following pumps:
 - a. Horizontally mounted, in-line, separately coupled centrifugal pumps.
 - b. Horizontally mounted, in-line, close-coupled centrifugal pumps.
 - c. Vertically mounted, in-line, close-coupled centrifugal pumps.
 - d. Comply with requirements for flexible connectors specified in Section 221116 "Domestic Water Piping."
- D. Install shutoff valve and strainer on suction side of each pump, and check, shutoff, and throttling valves on discharge side of each pump. Install valves same size as connected piping. Comply with requirements for strainers specified in Section 221119 "Domestic Water Piping Specialties." Comply with requirements for valves specified in the following:
 1. Section 220523.12 "Ball Valves for Plumbing Piping."
 2. Section 220523.13 "Butterfly Valves for Plumbing Piping."
 3. Section 220523.14 "Check Valves for Plumbing Piping."

4. Section 220523.15 "Gate Valves for Plumbing Piping."
5. Install pressure gauge at suction of each pump and pressure gauge and snubber at discharge of each pump. Install at integral pressure-gauge tapings where provided or install pressure-gauge connectors in suction and discharge piping around pumps. Comply with requirements for pressure gauges and snubbers.

5.04 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect control wiring between temperature controllers and devices.
- C. Interlock pump between water heater and hot-water storage tank with water heater burner and time-delay relay.

5.05 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment" for identification of pumps.

5.06 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections.
- E. Tests and Inspections:
 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- F. Inline, domestic-water pump will be considered defective if it does not pass tests and inspections.
- G. Prepare test and inspection reports.

5.07 STARTUP SERVICE

- A. Perform startup service.
 1. Complete installation and startup checks according to manufacturer's written instructions.
 2. Check piping connections for tightness.
 3. Clean strainers on suction piping.
 4. Set thermostats, timers for automatic starting and stopping operation of pumps.
 5. Perform the following startup checks for each pump before starting:
 - a. Verify bearing lubrication.
 - b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
 - c. Verify that pump is rotating in the correct direction.
 6. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
 7. Start motor.
 8. Open discharge valve slowly.
 9. Adjust temperature settings on thermostats.

10. Adjust timer settings.

5.08 ADJUSTING

- A. Adjust inline, domestic-water pumps to function smoothly, and lubricate as recommended by manufacturer.
- B. Adjust initial temperature set points.
- C. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

END OF SECTION

SECTION 22 13 13

FACILITY SANITARY SEWERS

PART 1 GENERAL

3.01 REFERENCE STANDARDS

- A. ASME A112.14.1 - Backwater Valves; 2003 (Reaffirmed 2022).
- B. ASTM A48/A48M - Standard Specification for Gray Iron Castings; 2022.
- C. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings; 2026.
- D. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement; 2026.
- E. ASTM A674 - Standard Practice for Polyethylene Encasement for Ductile Iron Pipe; 2022.
- F. ASTM A746 - Standard Specification for Ductile Iron Gravity Sewer Pipe; 2018 (Reapproved 2022).
- G. ASTM A1064/A1064M - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete; 2024.
- H. ASTM B29 - Standard Specification for Refined Lead; 2019 (Reapproved 2025).
- I. ASTM C14 - Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe; 2020 (Reapproved 2025).
- J. ASTM C33/C33M - Standard Specification for Concrete Aggregates; 2024a.
- K. ASTM C150/C150M - Standard Specification for Portland Cement; 2024.
- L. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets; 2021.
- M. ASTM C564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings; 2026.
- N. ASTM C1277 - Standard Specification for Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings; 2020.
- O. ASTM C1540 - Standard Specification for Heavy-Duty Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings; 2020.
- P. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications; 2025.
- Q. ASTM D2774 - Standard Practice for Underground Installation of Thermoplastic Pressure Piping; 2025.
- R. 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 (Reapproved 2024).
- S. ASTM D3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings; 2024, with Editorial Revision (2025).
- T. ASTM D3839 - Standard Guide for Underground Installation of "Fiberglass" (Glass-Fiber Reinforced Thermosetting-Resin) Pipe; 2025.
- U. ASTM D4161 - Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Joints Using Flexible Elastomeric Seals; 2024.
- V. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe; 2014 (Reapproved 2021).
- W. AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Pipe Systems; 2018.

- X. AWWA C110/A21.10 - Ductile-Iron and Gray-Iron Fittings; 2021.
- Y. AWWA C153/A21.53 - Ductile-Iron Compact Fittings; 2025.
- Z. AWWA C600 - Installation of Ductile-Iron Mains and Their Appurtenances; 2023.
- AA. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. through 60 In. (100 mm through 1500 mm); 2022.
- BB. AWWA M23 - PVC Pipe—Design and Installation; 2020.
- CC. AWWA M41 - Ductile-Iron Pipe and Fittings; 2025.
- DD. CISPI 301 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications; 2021.
- EE. CISPI 310 - Specification for Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications; 2020.

3.02 RELATED DOCUMENTS

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

3.03 SUMMARY

- A. Section Includes:
 - 1. Hub-and-spigot, cast-iron soil pipe and fittings.
 - 2. Hub-less cast-iron soil pipe and fittings.
 - 3. PVC pipe and fittings.
 - 4. Non-pressure-type transition couplings.
 - 5. Pressure-type pipe couplings.
 - 6. Expansion joints and deflection fittings.
 - 7. Backwater valves.
 - 8. Cleanouts.
 - 9. Encasement for piping.
 - 10. Manholes.
 - 11. Concrete.

3.04 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Pipe and fittings.
 - 2. Non-pressure and pressure couplings
 - 3. Expansion joints and deflection fittings.
 - 4. Backwater valves.
 - 5. Cleanouts.
- B. Shop Drawings: For manholes. Include plans, elevations, sections, details, and frames and covers.

3.05 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings:
 - 1. Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from sewer system piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.
 - 2. Show system piping in profile. Draw profiles to horizontal scale of not less than 1 inch (25.4 mm) equals 50 feet (1524 cm) and to vertical scale of not less than 1 inch equals 5 feet (152.4 cm). Indicate manholes and piping. Show types, sizes, materials, and elevations of other utilities crossing system piping.
- B. Product Certificates: For each type of pipe and fitting.

- C. Field quality-control reports.

3.06 DELIVERY, STORAGE, AND HANDLING

- A. Do not store plastic manholes, pipe, and fittings in direct sunlight.
- B. Protect pipe, pipe fittings, and seals from dirt and damage.
- C. Handle manholes according to manufacturer's written rigging instructions.

3.07 FIELD CONDITIONS

- A. Interruption of Existing Sanitary Sewerage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
 - 1. Notify Architect no fewer than two ???Insert number??? days in advance of proposed interruption of service.
 - 2. Do not proceed with interruption of service without Architect's written permission.

PART 2 PRODUCTS

4.01 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A74, Service class.
- B. Gaskets: ASTM C564, rubber.
- C. Calking Materials: ASTM B29, pure lead and oakum or hemp fiber.

4.02 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A888 or CISPI 301.
- B. CISPI-Trademark, Shielded Couplings:
 - 1. Description: ASTM C1277 and CISPI 310, with stainless-steel corrugated shield; stainless-steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ANACO-Husky.
 - b. Charlotte Pipe and Foundry Company.
 - c. Dallas Specialty & Mfg. Co.
 - d. Fernco Inc.
 - e. Mission Rubber Company, LLC; a division of MCP Industries.
 - f. Tyler Pipe; a subsidiary of McWane Inc.
- C. Heavy-Duty, Shielded Couplings:
 - 1. Description: ASTM C1277 and ASTM C1540, with stainless-steel shield; stainless-steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ANACO-Husky.
 - b. Clamp-All Corp.
 - c. Dallas Specialty & Mfg. Co.
 - d. Mission Rubber Company, LLC; a division of MCP Industries.
 - e. Tyler Pipe; a subsidiary of McWane Inc.
- D. Cast-Iron, Shielded Couplings:
 - 1. Description: ASTM C1277 with ASTM A48/A48M, two-piece, cast-iron housing; stainless-steel bolts and nuts; and ASTM C564, rubber sleeve with integral, center pipe stop.

-
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ANACO-Husky.
 - b. Charlotte Pipe and Foundry Company.
 - c. Clamp-All Corp.
 - d. Dallas Specialty & Mfg. Co.
 - e. MG Piping Products Company.
 - f. Mission Rubber Company, LLC; a division of MCP Industries.
 - g. Tyler Pipe; a subsidiary of McWane Inc.
 - E. Unshielded Couplings:
 1. Description: ASTM C1277 and ASTM C1461, rigid, sleeve-type, reducing- or transition-type mechanical coupling, with integral, center pipe stop, molded from ASTM C1440, thermoplastic elastomer (TPE) material; with corrosion-resistant-metal tension band and tightening mechanism on each end.
 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ANACO-Husky.
 - b. Charlotte Pipe and Foundry Company.
 - c. Clamp-All Corp.
 - d. Dallas Specialty & Mfg. Co.
 - e. MG Piping Products Company.
 - f. Mission Rubber Company, LLC; a division of MCP Industries.
 - g. Tyler Pipe; a subsidiary of McWane Inc.
 - F. PVC Gravity Sewer Piping:
 1. Pipe and Fittings: ASTM F679, T-1 wall thickness, PVC gravity sewer pipe with bell-and-spigot ends and with integral ASTM F477, elastomeric seals for gasketed joints.
 - G. PVC Pressure Piping:
 1. Pipe: AWWA C900, Class 150 PVC pipe with bell-and-spigot ends for gasketed joints.
 2. Fittings: AWWA C900, Class 150 PVC pipe with bell ends.
 3. Gaskets: ASTM F477, elastomeric seals.
- #### 4.03 NONPRESSURE-TYPE TRANSITION COUPLINGS
- A. Comply with ASTM C1173, elastomeric, sleeve-type, reducing or transition coupling; for joining underground non-pressure piping. Include ends of same sizes as piping to be joined and include corrosion-resistant-metal tension band and tightening mechanism on each end.
 - B. Sleeve Materials:
 1. For Cast-Iron Soil Pipes: ASTM C564, rubber.
 2. For Concrete Pipes: ASTM C443, rubber.
 3. For Fiberglass Pipes: ASTM F477, elastomeric seal or ASTM D5926, PVC.
 4. For Plastic Pipes: ASTM F477, elastomeric seal or ASTM D5926, PVC.
 5. For Dissimilar Pipes: ASTM D5926, PVC or other material compatible with pipe materials being joined.
 - C. Unshielded, Flexible Couplings:
 1. Description: Elastomeric sleeve with stainless-steel shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Dallas Specialty & Mfg. Co.
 - b. Fernco Inc.
 - c. Logan Clay Pipe.

- d. Mission Rubber Company, LLC; a division of MCP Industries.
 - e. NDS Inc.
 - f. Plastic Oddities.
- D. Shielded, Flexible Couplings:
 - 1. Description: ASTM C1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Cascade Waterworks Mfg. Co.
 - b. Dallas Specialty & Mfg. Co.
 - c. Mission Rubber Company, LLC; a division of MCP Industries.
- E. Ring-Type, Flexible Couplings:
 - 1. Description: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Fernco Inc.
 - b. Logan Clay Pipe.
 - c. Mission Rubber Company, LLC; a division of MCP Industries.
- F. Non-pressure-Type, Rigid Couplings:
 - 1. Description: ASTM C1461, sleeve-type, reducing- or transition-type mechanical coupling; molded from ASTM C1440, TPE material; with corrosion-resistant-metal tension band and tightening mechanism on each end.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. ANACO-Husky.

4.04 EXPANSION JOINTS AND DEFLECTION FITTINGS

- A. Ductile-Iron, Flexible Expansion Joints:
 - 1. Description: Compound fitting with combination of flanged and mechanical-joint ends complying with AWWA C110/A21.10 or AWWA C153/A21.53. Include two gasketed ball-joint sections and one or more gasketed sleeve sections, rated for 250-psig minimum working pressure and for offset and expansion indicated.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. EBAA Iron, Inc.
 - b. Romac Industries, Inc.
 - c. Star Pipe Products.
- B. Ductile-Iron Expansion Joints:
 - 1. Description: Three-piece assembly of telescoping sleeve with gaskets and restrained-type, ductile-iron, bell-and-spigot end sections complying with AWWA C110/A21.10 or AWWA C153/A21.53. Include rating for 250-psig (1725-kPa) minimum working pressure and for expansion indicated.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Dresser, Inc.
 - b. EBAA Iron, Inc.
 - c. Jay R. Smith Mfg Co; a division of Morris Group International.
 - d. JCM Industries, Inc.

4.05 BACKWATER VALVES

- A. Cast-Iron Backwater Valves:
 - 1. Description: ASME A112.14.1, gray-iron body and bolted cover, with bronze seat.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Jay R. Smith Mfg Co; a division of Morris Group International.
 - b. Josam Company.
 - c. Tyler Pipe; a subsidiary of McWane Inc.
 - d. WATTS.
 - e. Zurn Industries, LLC.
 - 3. Horizontal type; with swing check valve and hub-and-spigot ends.
 - 4. Combination horizontal and manual gate-valve type; with swing check valve, integral gate valve, and hub-and-spigot ends.
 - 5. Terminal type; with bronze seat, swing check valve, and hub inlet.
- B. PVC Backwater Valves:
 - 1. Description: Horizontal type; with PVC body, PVC removable cover, and PVC swing check valve.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Canplas LLC.
 - b. IPS Corporation.
 - c. NDS Inc.
 - d. Plastic Oddities.
 - e. Sioux Chief Manufacturing Company, Inc.
 - f. Zurn Industries, LLC.

4.06 CLEANOUTS

- A. Cast-Iron Cleanouts:
 - 1. Description: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Jay R. Smith Mfg Co; a division of Morris Group International.
 - b. Josam Company.
 - c. MIFAB, Inc.
 - d. Tyler Pipe; a subsidiary of McWane Inc.
 - e. WATTS.
 - f. Zurn Industries, LLC.
 - 3. Top-Loading Classification(s): Medium Duty and Extra-Heavy Duty.
 - 4. Sewer Pipe Fitting and Riser to Cleanout: ASTM A74, Service class, cast-iron soil pipe and fittings.
- B. PVC Cleanouts:
 - 1. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Canplas LLC.
 - b. IPS Corporation.
 - c. NDS Inc.

- d. Plastic Oddities.
- e. Sioux Chief Manufacturing Company, Inc.
- f. Zurn Industries, LLC.

4.07 CONCRETE

- A. General: Cast-in-place concrete complying with ACI 318, ACI 350 (ACI 350M), and the following:
 - 1. Cement: ASTM C150/C150M, Type II.
 - 2. Fine Aggregate: ASTM C33/C33M, sand.
 - 3. Coarse Aggregate: ASTM C33/C33M, crushed gravel.
 - 4. Water: Potable.
- B. Portland Cement Design Mix: 4000 psi (27579.04 kPa) minimum, with 0.45 maximum water/cementitious materials ratio.
 - 1. Reinforcing Fabric: ASTM A1064/A1064M, steel, welded wire fabric, plain.
 - 2. Reinforcing Bars: ASTM A615/A615M, Grade 60 deformed steel.
- C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi (27579.04 kPa) minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.
 - 1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
 - a. Invert Slope: 2 percent through manhole.
 - 2. Benches: Concrete, sloped to drain into channel.
 - a. Slope: 4 percent.
- D. Ballast and Pipe Supports: Portland cement design mix, 3000 psi (20684.28 kPa) minimum, with 0.58 maximum water/cementitious materials ratio.
 - 1. Reinforcing Fabric: ASTM A1064/A1064M, steel, welded wire fabric, plain.
 - 2. Reinforcing Bars: ASTM A615/A615M, Grade 60 (deformed steel).

PART 3 EXECUTION

5.01 EARTHWORK

- A. Excavating, trenching, and backfilling are specified in Section 312000 "Earth Moving."

5.02 PIPING INSTALLATION

- A. General Locations and Arrangements: Drawing plans and details to indicate general location and arrangement of underground sanitary sewer piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
- B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.
- C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.
- D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
- E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.
- F. Install gravity-flow, nonpressure, drainage piping according to the following:

-
1. Install piping pitched down in direction of flow, at minimum slope of 1 percent unless otherwise indicated.
 2. Install piping NPS 6 and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place-concrete supports or anchors.
 3. Install piping with 48-inch minimum cover.
 4. Install hub-and-spigot, cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
 5. Install hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
 6. Install ductile-iron, gravity sewer piping according to ASTM A746.
 7. Install ABS sewer piping according to ASTM D2321 and ASTM F1668.
 8. Install PVC cellular-core sewer piping according to ASTM D2321 and ASTM F1668.
 9. Install PVC corrugated sewer piping according to ASTM D2321 and ASTM F1668.
 10. Install PVC profile sewer piping according to ASTM D2321 and ASTM F1668.
 11. Install PVC Type PSM sewer piping according to ASTM D2321 and ASTM F1668.
 12. Install PVC gravity sewer piping according to ASTM D2321 and ASTM F1668.
 13. Install fiberglass sewer piping according to ASTM D3839 and ASTM F1668.
 14. Install nonreinforced-concrete sewer piping according to ASTM C1479 and ACPA's "Concrete Pipe Installation Manual."
 15. Install reinforced-concrete sewer piping according to ASTM C1479 and ACPA's "Concrete Pipe Installation Manual."
- G. Install force-main, pressure piping according to the following:
1. Install piping with restrained joints at tee fittings and at horizontal and vertical changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place-concrete supports or anchors.
 2. Install piping with 36-inch minimum cover.
 3. Install ductile-iron pressure piping according to AWWA C600 or AWWA M41.
 4. Install ductile-iron special fittings according to AWWA C600.
 5. Install PVC pressure piping according to AWWA M23 or to ASTM D2774 and ASTM F1668.
 6. Install PVC water-service piping according to ASTM D2774 and ASTM F1668.
- H. Install corrosion-protection piping encasement over the following underground metal piping according to ASTM A674 or AWWA C105/A21.5:
1. Hub-and-spigot, cast-iron soil pipe.
 2. Hubless cast-iron soil pipe and fittings.
 3. Expansion joints and deflection fittings.
- I. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.
- 5.03 PIPE JOINT CONSTRUCTION
- A. Join gravity-flow, non-pressure, drainage piping according to the following:
1. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
 2. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.
 3. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.
 4. Join ductile-iron, gravity sewer piping according to AWWA C600 for push-on joints.
 5. Join ABS sewer piping according to ASTM D2321 for elastomeric-seal joints.

6. Join PVC cellular-core sewer piping according to ASTM D2321 and ASTM F891 for solvent-cemented joints.
 7. Join PVC corrugated sewer piping according to ASTM D2321.
 8. Join PVC profile sewer piping according to ASTM D2321 for elastomeric-seal joints or ASTM F794 for gasketed joints.
 9. Join PVC Type PSM sewer piping according to ASTM D2321 and ASTM D3034 for elastomeric-seal joints or ASTM D3034 for elastomeric-gasket joints.
 10. Join PVC gravity sewer piping according to ASTM D2321 and ASTM D3034 for elastomeric-seal joints or ASTM D3034 for elastomeric-gasket joints.
 11. Join fiberglass sewer piping according to ASTM D4161 for elastomeric-seal joints.
 12. Join nonreinforced-concrete sewer piping according to ASTM C14 (ASTM C14M) and ACPA's "Concrete Pipe Installation Manual" for rubber-gasket joints.
 13. Join reinforced-concrete sewer piping according to ACPA's "Concrete Pipe Installation Manual" for rubber-gasket joints.
 14. Join dissimilar pipe materials with nonpressure-type, flexible or rigid couplings.
- B. Join force-main, pressure piping according to the following:
1. Join ductile-iron pressure piping according to AWWA C600 or AWWA M41 for push-on joints.
 2. Join ductile-iron special fittings according to AWWA C600 or AWWA M41 for push-on joints.
 3. Join PVC pressure piping according to AWWA M23 for gasketed joints.
 4. Join PVC water-service piping according to ASTM D2855.
 5. Join dissimilar pipe materials with pressure-type couplings.
- C. Pipe couplings, expansion joints, and deflection fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
1. Use non-pressure flexible couplings where required to join gravity-flow, nonpressure sewer piping unless otherwise indicated.
 - a. Shielded flexible couplings for pipes of same or slightly different OD.
 - b. Unshielded, increaser/reducer-pattern, flexible or rigid couplings for pipes with different OD.
 - c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.
 2. Use pressure pipe couplings for force-main joints.

5.04 CONCRETE PLACEMENT

- A. Place cast-in-place concrete according to ACI 318.

5.05 BACKWATER VALVE INSTALLATION

- A. Install horizontal-type backwater valves in piping manholes or pits.
- B. Install combination horizontal and manual gate-type valves in piping and in manholes.
- C. Install terminal-type backwater valves on end of piping and in manholes. Secure units to sidewalls.

5.06 CLEANOUT INSTALLATION

- A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts, and use cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.
1. Use Light-Duty, top-loading classification cleanouts in unpaved foot-traffic areas.
 2. Use Medium-Duty, top-loading classification cleanouts in paved foot-traffic areas.
 3. Use Heavy-Duty, top-loading classification cleanouts in vehicle-traffic service areas.
 4. Use Extra-Heavy-Duty, top-loading classification cleanouts in roads.

- B. Set cleanout frames and covers in earth in cast-in-place-concrete block, 18 by 18 by 12 inches (304.8 mm) deep. Set with tops 1 inch (25.4 mm) above surrounding grade.
- C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

5.07 CONNECTIONS

- A. Connect non-pressure, gravity-flow drainage piping to building's sanitary building drains specified in Section 221316 "Sanitary Waste and Vent Piping."
- B. Connect force-main piping to building's sanitary force mains specified in Section 221316 "Sanitary Waste and Vent Piping." Terminate piping where indicated.
- C. Make connections to existing piping and underground manholes.
 - 1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye fitting plus 6-inch (150-mm) overlap with not less than 6 inches (152.4 mm) of concrete with 28-day compressive strength of 3000 psi (20684.28 kPa).
 - 2. Make branch connections from side into existing piping, NPS 4 to NPS 20 (DN 100 to DN 500). Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches (152.4 mm) of concrete with 28-day compressive strength of 3000 psi (20684.28 kPa).
 - 3. Make branch connections from side into existing piping, NPS 21 (DN 525) or larger, or to underground manholes by cutting opening into existing unit large enough to allow 3 inches (76.2 mm) of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of, and be flush with, inside wall unless otherwise indicated. On outside of pipe or manhole wall, encase entering connection in 6 inches (152.4 mm) of concrete for minimum length of 12 inches (304.8 mm) to provide additional support of collar from connection to undisturbed ground.
 - a. Use concrete that will attain a minimum 28-day compressive strength of 3000 psi (20684.28 kPa) unless otherwise indicated.
 - b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.
 - 4. Protect existing piping and manholes to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.
- D. Connect to grease interceptors specified in Section 221323 "Sanitary Waste Interceptors."

5.08 IDENTIFICATION

- A. Comply with requirements in Section 312000 "Earth Moving" for underground utility identification devices. Arrange for installation of green warning tapes directly over piping and at outside edges of underground manholes.
 - 1. Use warning tape or detectable warning tape over ferrous piping.
 - 2. Use detectable warning tape over nonferrous piping and over edges of underground manholes.

5.09 FIELD QUALITY CONTROL

- A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches (609.6 mm) of backfill is in place, and again at completion of Project.
 - 1. Submit separate report for each system inspection.
 - 2. Defects requiring correction include the following:
 - a. Alignment: Less than full diameter of inside of pipe is visible between structures.
 - b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.

-
- c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
 - d. Infiltration: Water leakage into piping.
 - e. Exfiltration: Water leakage from or around piping.
 3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
 4. Reinspect and repeat procedure until results are satisfactory.
 - B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
 1. Do not enclose, cover, or put into service before inspection and approval.
 2. Test completed piping systems according to requirements of authorities having jurisdiction.
 3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
 4. Submit separate report for each test.
 5. Hydrostatic Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction and the following:
 - a. Fill sewer piping with water. Test with pressure of at least 10-foot (3-m) head of water, and maintain such pressure without leakage for at least 15 minutes.
 - b. Close openings in system and fill with water.
 - c. Purge air and refill with water.
 - d. Disconnect water supply.
 - e. Test and inspect joints for leaks.
 6. Air Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
 - a. Test plastic gravity sewer piping according to ASTM F1417.
 - b. Test concrete gravity sewer piping according to ASTM C1628.
 7. Force Main: Perform hydrostatic test after thrust blocks, supports, and anchors have hardened. Test at pressure not less than 1-1/2 times the maximum system operating pressure, but not less than 150 psig (1034.21 kPa).
 - a. Ductile-Iron Piping: Test according to AWWA C600, "Hydraulic Testing" Section.
 - b. PVC Piping: Test according to AWWA M23, "Testing and Maintenance" Chapter.
 8. Manholes: Perform hydraulic test according to ASTM C969 (ASTM C969M).
 - C. Leaks and loss in test pressure constitute defects that must be repaired.
 - D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.
- 5.10 CLEANING
- A. Clean dirt and superfluous material from interior of piping. Flush with potable water.

END OF SECTION

SECTION 22 13 16

SANITARY WASTE AND VENT PIPING

PART 1 GENERAL

3.01 REFERENCE STANDARDS

- A. ASME A112.3.1 - Stainless Steel Drainage Systems for Sanitary DWV, Storm, and Vacuum Applications Above and Below Ground; 2007 (Reaffirmed 2022).
- B. ASME B1.20.1 - Pipe Threads, General Purpose, Inch; 2013 (Reaffirmed 2018).
- C. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2021.
- D. ASME B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges; 2021.
- E. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2021.
- F. ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings: DWV; 2021.
- G. ASME B16.24 - Cast Copper Alloy Pipe Flanges, Flanged Fittings, and Valves: Classes 150, 300, 600, 900, 1500, and 2500; 2021.
- H. ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder-Joint Drainage Fittings—DWV; 2022.
- I. ASME B18.2.1 - Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series); 2012 (Reaffirmed 2021).
- J. ASTM A48/A48M - Standard Specification for Gray Iron Castings; 2022.
- K. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings; 2026.
- L. ASTM A536 - Standard Specification for Ductile Iron Castings; 2024.
- M. ASTM A674 - Standard Practice for Polyethylene Encasement for Ductile Iron Pipe; 2022.
- N. ASTM B29 - Standard Specification for Refined Lead; 2019 (Reapproved 2025).
- O. ASTM B32 - Standard Specification for Solder Metal; 2020.
- P. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2022.
- Q. ASTM B306 - Standard Specification for Copper Drainage Tube (DWV); 2026.
- R. ASTM B813 - Standard Specification for Water Flushable Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube; 2024.
- S. ASTM B828 - Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings; 2023.
- T. ASTM C564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings; 2026.
- U. ASTM C1277 - Standard Specification for Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings; 2020.
- V. ASTM C1540 - Standard Specification for Heavy-Duty Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings; 2020.
- W. ASTM D2235 - Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings; 2022.
- X. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications; 2025.
- Y. ASTM D2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems; 2020 (Reapproved 2024).

- Z. ASTM D2661 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings; 2024.
- AA. ASTM D2665 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings; 2025.
- BB. 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 (Reapproved 2024).
- CC. ASTM D3311 - Standard Specification for Drain, Waste, and Vent (DWV) Plastic Fittings Patterns; 2022 .
- DD. ASTM F402 - Standard Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings; 2026.
- EE. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe; 2014 (Reapproved 2021).
- FF. ASTM F628 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe with a Cellular Core; 2024.
- GG. ASTM F656 - Standard Specification for Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) and Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings; 2025.
- HH. ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications; 2007 (Reapproved 2024).
- II. AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Pipe Systems; 2018.
- JJ. AWWA C110/A21.10 - Ductile-Iron and Gray-Iron Fittings; 2021.
- KK. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings; 2023.
- LL. AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast; 2023.
- MM. AWWA C153/A21.53 - Ductile-Iron Compact Fittings; 2025.
- NN. AWWA C600 - Installation of Ductile-Iron Mains and Their Appurtenances; 2023.
- OO. AWWA C606 - Grooved and Shouldered Joints; 2022.
- PP. CISPI 301 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications; 2021.
- QQ. CISPI 310 - Specification for Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications; 2020.
- RR. NSF 14 - Plastics Piping System Components and Related Materials; 2025.

3.02 RELATED DOCUMENTS

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

3.03 SUMMARY

- A. Section Includes:
 - 1. Hub-and-spigot, cast-iron soil pipe and fittings.
 - 2. Hubless, cast-iron soil pipe and fittings.
 - 3. Galvanized-steel pipe and fittings.
 - 4. Stainless-steel drainage pipe and fittings.
 - 5. Ductile-iron pipe and fittings.
 - 6. Copper tube and fittings.
 - 7. ABS pipe and fittings.
 - 8. PVC pipe and fittings.

9. Specialty pipe fittings.
10. Encasement for underground metal piping.

B. Related Requirements:

1. Section 221313 "Facility Sanitary Sewers" for sanitary sewerage piping and structures outside the building.
2. Section 221329 "Sanitary Sewerage Pumps" for effluent and sewage pumps.
3. Section 226600 "Chemical-Waste Systems for Laboratory and Healthcare Facilities" for chemical-waste and vent piping systems.

3.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Sustainable Design Submittals:
- C. Shop Drawings: For hub-less, single-stack drainage system. Include plans, elevations, sections, and details.

3.05 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For waste and vent piping, accessories, and components, from manufacturer.
 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 2. Detailed description of piping anchorage devices on which the certification is based and their installation requirements.
- B. Field quality-control reports.

3.06 WARRANTY

- A. Listed manufacturers to provide labeling and warranty of their respective products.

PART 2 PRODUCTS

4.01 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
 1. Soil, Waste, and Vent Piping: 10-foot head of water.
 2. Waste, Force-Main Piping: 100 psig (689.48 kPa) .

4.02 PIPING MATERIALS

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

4.03 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. AB & I Foundry; a part of the McWane family of companies.
 2. Charlotte Pipe and Foundry Company.
 3. NewAge Casting.
 4. Tyler Pipe; a part of McWane family of companies.
- B. Pipe and Fittings: ASTM A74, Extra Heavy class(es).
- C. Gaskets: ASTM C564, rubber.
- D. Caulking Materials: ASTM B29, pure lead and oakum or hemp fiber.

4.04 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. AB & I Foundry; a part of the McWane family of companies.
 - 2. Charlotte Pipe and Foundry Company.
 - 3. NewAge Casting.
 - 4. Tyler Pipe; a part of McWane family of companies.
- B. Pipe and Fittings: ASTM A 888 or CISPI 301.
- C. Single-Stack Aerator Fittings: ASME B16.45, hubless, cast-iron aerator and deaerator drainage fittings.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Conine Manufacturing Co., Inc.
 - b. SE Sovent.
- D. CISPI, Hubless-Piping Couplings:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ANACO-Husky.
 - b. Charlotte Pipe and Foundry Company.
 - c. Dallas Specialty & Mfg. Co.
 - d. Fernco Inc.
 - e. Ideal Clamp Products, Inc.
 - f. Josam Company.
 - g. Matco-Norca.
 - h. MIFAB, Inc.
 - i. Mission Rubber Company, LLC; a division of MCP Industries.
 - j. NewAge Casting.
 - k. Tyler Pipe; a subsidiary of McWane Inc.
 - 2. Standards: ASTM C1277 and CISPI 310.
 - 3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.
- E. Heavy-Duty, Hub-less-Piping Couplings:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ANACO-Husky.
 - b. Charlotte Pipe and Foundry Company.
 - c. Clamp-All Corp.
 - d. Dallas Specialty & Mfg. Co.
 - e. Ideal Clamp Products, Inc.
 - f. MIFAB, Inc.
 - g. Mission Rubber Company, LLC; a division of MCP Industries.
 - h. NewAge Casting.
 - i. Tyler Pipe; a subsidiary of McWane Inc.
 - 2. Standards: ASTM C1277 and ASTM C1540.
 - 3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.
- F. Cast-Iron, Hub-less-Piping Couplings:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Charlotte Pipe and Foundry Company.
- b. MG Piping Products Company.
2. Standard: ASTM C1277.
3. Description: Two-piece ASTM A48/A48M, cast-iron housing; stainless-steel bolts and nuts; and ASTM C564, rubber sleeve with integral, center pipe stop.

4.05 DUCTILE-IRON PIPE AND FITTINGS

- A. Ductile-Iron, Mechanical-Joint Piping:
 1. Ductile-Iron Pipe: AWWA C151/A21.51, with mechanical-joint bell and plain spigot ends unless grooved or flanged ends are indicated.
 2. Ductile-Iron Fittings: AWWA C110/A21.10, mechanical-joint, ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
 3. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
- B. Ductile-Iron, Push-on-Joint Piping:
 1. Ductile-Iron Pipe: AWWA C151/A21.51, with push-on-joint bell and plain spigot ends unless grooved or flanged ends are indicated.
 2. Ductile-Iron Fittings: AWWA C110/A21.10, push-on-joint, ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
 3. Gaskets: AWWA C111/A21.11, rubber.
- C. Ductile-Iron, Grooved-Joint Piping: AWWA C151/A21.51, with round-cut-grooved ends according to AWWA C606.
- D. Ductile-Iron, Grooved-End Pipe Appurtenances:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International.
 - b. Shurjoint-Apollo Piping Products USA Inc.
 - c. Smith-Cooper International.
 - d. Star Pipe Products.
 - e. Victaulic Company.
 2. Grooved-End, Ductile-Iron Fittings: ASTM A536 ductile-iron castings, with dimensions matching AWWA C110/A21.10 ductile-iron pipe or AWWA C153/A21.53 ductile-iron fittings, and complying with AWWA C606 for grooved ends.
 3. Grooved Mechanical Couplings for Ductile-Iron Pipe: ASTM F1476, Type I. Include ferrous housing sections with continuous curved keys; EPDM-rubber center-leg gasket suitable for hot and cold water; and bolts and nuts.

4.06 COPPER TUBE AND FITTINGS

- A. Copper Type DWV Tube: ASTM B306, drainage tube, drawn temper.
- B. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.
- C. Hard Copper Tube: ASTM B88, Type L and Type M, water tube, drawn temper.
- D. Soft Copper Tube: ASTM B88, Type L, water tube, annealed temper.
- E. Copper Pressure Fittings:
 1. Copper Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
 2. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
- F. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.

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

G. Solder: ASTM B32, lead free with ASTM B813, water-flushable flux.

4.07 ABS PIPE AND FITTINGS

- A. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.
- B. Solid-Wall ABS Pipe: ASTM D2661, Schedule 40.
- C. Cellular-Core ABS Pipe: ASTM F628, Schedule 40.
- D. ABS Socket Fittings: ASTM D2661, made to ASTM D3311, drain, waste, and vent patterns.
- E. Solvent Cement: ASTM D2235.

4.08 PVC PIPE AND FITTINGS

- A. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.
- B. Solid-Wall PVC Pipe: ASTM D2665, drain, waste, and vent.
- C. Cellular-Core PVC Pipe: ASTM F 891, Schedule 40.
- D. PVC Socket Fittings: ASTM D2665, made to ASTM D3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
- E. Adhesive Primer: ASTM F656.
- F. Solvent Cement: ASTM D2564.

4.09 SPECIALTY PIPE FITTINGS

- A. Transition Couplings:
 1. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
 2. Unshielded, Nonpressure Transition Couplings:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Dallas Specialty & Mfg. Co.
 - 2) Fernco Inc.
 - 3) Froet Industries LLC.
 - 4) Mission Rubber Company, LLC; a division of MCP Industries.
 - 5) Plastic Oddities.
 - b. Standard: ASTM C 1173.
 - c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - d. End Connections: Same size as and compatible with pipes to be joined.
 - e. Sleeve Materials:
 - 1) For Cast-Iron Soil Pipes: ASTM C564, rubber.
 - 2) For Plastic Pipes: ASTM F477, elastomeric seal or ASTM D 5926, PVC.
 - 3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
 3. Shielded, Non-pressure Transition Couplings:

-
- a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Cascade Waterworks Mfg. Co.
 - 2) Mission Rubber Company, LLC; a division of MCP Industries.
 - b. Standard: ASTM C 1460.
 - c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - d. End Connections: Same size as and compatible with pipes to be joined.
- B. Dielectric Fittings:
- 1. Dielectric Unions:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) A.Y. McDonald Mfg. Co.
 - 2) Capitol Manufacturing Company.
 - 3) Central Plastics Company.
 - 4) HART Industrial Unions, LLC.
 - 5) Jomar Valve.
 - 6) Matco-Norca.
 - 7) WATTS.
 - 8) Wilkins.
 - 9) Zurn Industries, LLC.
 - b. Description:
 - 1) Standard: ASSE 1079.
 - 2) Pressure Rating: 125 psig (861.84 kPa) minimum at 180 deg F.
 - 3) End Connections: Solder-joint copper alloy and threaded ferrous.
 - 2. Dielectric Flanges:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Capitol Manufacturing Company.
 - 2) Central Plastics Company.
 - 3) Matco-Norca.
 - 4) WATTS.
 - 5) Wilkins.
 - 6) Zurn Industries, LLC.
 - b. Description:
 - 1) Standard: ASSE 1079.
 - 2) Factory-fabricated, bolted, companion-flange assembly.
 - 3) Pressure Rating: 125 psig (861.84 kPa) minimum at 180 deg F.
 - 4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
 - 3. Dielectric-Flange Insulating Kits:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Advance Products & Systems, Inc.
 - 2) Calpico, Inc.
 - 3) Central Plastics Company.
 - 4) Pipeline Seal and Insulator, Inc.
 - b. Description:
 - 1) Nonconducting materials for field assembly of companion flanges.

- 2) Pressure Rating: 150 psig (1034.21 kPa) .
- 3) Gasket: Neoprene or phenolic.
- 4) Bolt Sleeves: Phenolic or polyethylene.
- 5) Washers: Phenolic with steel backing washers.
4. Dielectric Nipples:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Elster Perfection Corporation.
 - 2) Grinnell G-Fire by Johnson Controls Company.
 - 3) Josam Company.
 - 4) Matco-Norca.
 - 5) Precision Plumbing Products.
 - 6) Victaulic Company.
 - b. Description:
 - 1) Standard: IAPMO PS 66.
 - 2) Electroplated steel nipple.
 - 3) Pressure Rating: 300 psig (2068.43 kPa) at 225 deg F .
 - 4) End Connections: Male threaded or grooved.
 - 5) Lining: Inert and noncorrosive, propylene.

PART 3 EXECUTION

5.01 EARTH MOVING

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

5.02 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.
 1. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
 2. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.
- J. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends.
 1. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical.
 2. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe.

-
- a. Straight tees, elbows, and crosses may be used on vent lines.
 - 3. Do not change direction of flow more than 90 degrees.
 - 4. Use proper size of standard increasers and reducers if pipes of different sizes are connected.
 - a. Reducing size of waste piping in direction of flow is prohibited.
 - K. Lay buried building waste piping beginning at low point of each system.
 - 1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
 - 2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
 - 3. Maintain swab in piping and pull past each joint as completed.
 - L. Install soil and waste and vent piping at the following minimum slopes unless otherwise indicated:
 - 1. Building Sanitary Waste: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
 - 2. Horizontal Sanitary Waste Piping: 2 percent downward in direction of flow.
 - 3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
 - M. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
 - 1. Install encasement on underground piping according to ASTM A674 or AWWA C105/A21.5.
 - N. Install steel piping according to applicable plumbing code.
 - O. Install stainless-steel piping according to ASME A112.3.1 and applicable plumbing code.
 - P. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."
 - Q. Install aboveground ABS piping according to ASTM D2661.
 - R. Install aboveground PVC piping according to ASTM D2665.
 - S. Install underground PVC piping according to ASTM D2321.
 - T. Install engineered soil and waste and vent piping systems as follows:
 - 1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
 - 2. Hub-less, Single-Stack Drainage System: Comply with ASME B16.45 and hubless, single-stack aerator fitting manufacturer's written installation instructions.
 - 3. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.
 - U. Install underground, ductile-iron, force-main piping according to AWWA C600.
 - 1. Install buried piping inside building between wall and floor penetrations and connection to sanitary sewer piping outside building with restrained joints.
 - 2. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.
 - 3. Install encasement on piping according to ASTM A674 or AWWA C105/A21.5.
 - V. Install underground, copper, force-main tubing according to CDA's "Copper Tube Handbook."
 - 1. Install encasement on piping according to ASTM A674 or AWWA C105/A21.5.
 - W. Install force mains at elevations indicated.
 - X. Plumbing Specialties:
 - 1. Install backwater valves in sanitary waster gravity-flow piping.
 - a. Comply with requirements for backwater valves specified in Section 221319 "Sanitary Waste Piping Specialties."
 - 2. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary waste gravity-flow piping.

- a. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping.
 - b. Comply with requirements for cleanouts specified in Section 221319 "Sanitary Waste Piping Specialties."
- 3. Install drains in sanitary waste gravity-flow piping.
 - a. Comply with requirements for drains specified in Section 221319 "Sanitary Waste Piping Specialties."
- Y. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- Z. Install sleeves for piping penetrations of walls, ceilings, and floors.
 - 1. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- AA. Install sleeve seals for piping penetrations of concrete walls and slabs.
 - 1. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- BB. Install escutcheons for piping penetrations of walls, ceilings, and floors.
 - 1. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

5.03 JOINT CONSTRUCTION

- A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- B. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum calked joints.
- C. Join hub-less, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hub-less-piping coupling joints.
- D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1.
 - 1. Cut threads full and clean using sharp dies.
 - 2. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
 - c. Do not use pipe sections that have cracked or open welds.
- E. Join stainless-steel pipe and fittings with gaskets according to ASME A112.3.1.
- F. Join copper tube and fittings with soldered joints according to ASTM B828. Use ASTM B813, water-flushable, lead-free flux and ASTM B32, lead-free-alloy solder.
- G. Grooved Joints: Cut groove ends of pipe according to AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.
- H. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.
- I. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.

2. ABS Piping: Join according to ASTM D2235 and ASTM D2661 appendixes.
 3. PVC Piping: Join according to ASTM D2855 and ASTM D2665 appendixes.
- J. Dielectric Fittings:
1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
 2. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.
 3. Dielectric Fittings for NPS 2-1/2 to NPS 4 : Use dielectric flanges.

5.04 VALVE INSTALLATION

- A. Comply with requirements in Section 220523.12 "Ball Valves for Plumbing Piping," Section 220523.13 "Butterfly Valves for Plumbing Piping," Section 220523.14 "Check Valves for Plumbing Piping," and Section 220523.15 "Gate Valves for Plumbing Piping" for general-duty valve installation requirements.
- B. Shutoff Valves:
1. Install shutoff valve on each sewage pump discharge.
 2. Install gate or full-port ball valve for piping NPS 2 and smaller.
 3. Install gate valve for piping NPS 2-1/2 and larger.
- C. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.
- D. Backwater Valves: Install backwater valves in piping subject to backflow.
1. Horizontal Piping: Horizontal backwater valves. Use normally closed type unless otherwise indicated.
 2. Floor Drains: Drain outlet backwater valves unless drain has integral backwater valve.
 3. Install backwater valves in accessible locations.
 4. Comply with requirements for backwater valve specified in Section 221319 "Sanitary Waste Piping Specialties."

5.05 INSTALLATION OF HANGERS AND SUPPORTS

- A. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
 2. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
 3. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
 4. Vertical Piping: MSS Type 8 or Type 42, clamps.
 5. Install individual, straight, horizontal piping runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
 6. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 7. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Install hangers for cast-iron soil piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- D. Install hangers for PVC piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

- E. Support horizontal piping and tubing within 12 inches (304.8 mm) of each fitting, valve, and coupling.

5.06 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect waste and vent piping to the following:
 - 1. Plumbing Fixtures: Connect waste piping in sizes indicated, but not smaller than required by plumbing code.
 - 2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
 - 3. Plumbing Specialties: Connect waste and vent piping in sizes indicated, but not smaller than required by plumbing code.
 - 4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
 - 5. Equipment: Connect waste piping as indicated.
 - a. Provide shutoff valve if indicated and union for each connection.
 - b. Use flanges instead of unions for connections NPS 2-1/2 and larger.
- D. Connect force-main piping to the following:
 - 1. Sanitary Sewer: To exterior force main.
 - 2. Sewage Pump: To sewage pump discharge.
- E. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
- F. Make connections according to the following unless otherwise indicated:
 - 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
 - 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

5.07 IDENTIFICATION

- A. Identify exposed sanitary waste and vent piping.
- B. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

5.08 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 - 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test sanitary waste and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.

-
- a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 2. Leave uncovered and unconcealed new, altered, extended, or replaced waste and vent piping until it has been tested and approved.
 - a. Expose work that was covered or concealed before it was tested.
 3. Roughing-in Plumbing Test Procedure: Test waste and vent piping except outside leaders on completion of roughing-in.
 - a. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water.
 - b. From 15 minutes before inspection starts to completion of inspection, water level must not drop.
 - c. Inspect joints for leaks.
 4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight.
 - a. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg.
 - b. Use U-tube or manometer inserted in trap of water closet to measure this pressure.
 - c. Air pressure must remain constant without introducing additional air throughout period of inspection.
 - d. Inspect plumbing fixture connections for gas and water leaks.
 5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 6. Prepare reports for tests and required corrective action.
 - E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved.
 - a. Expose work that was covered or concealed before it was tested.
 2. Cap and subject piping to static-water pressure of 50 psig (344.74 kPa) above operating pressure, without exceeding pressure rating of piping system materials.
 - a. Isolate test source and allow to stand for four hours.
 - b. Leaks and loss in test pressure constitute defects that must be repaired.
 3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 4. Prepare reports for tests and required corrective action.

5.09 CLEANING AND PROTECTION

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect sanitary waste and vent piping during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.
- D. Exposed ABS Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.
- E. Repair damage to adjacent materials caused by waste and vent piping installation.

5.10 PIPING SCHEDULE

- A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- B. Aboveground, soil and waste piping NPS 4 and smaller shall be the following:
 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 2. Hubless, cast-iron soil pipe and fittings hubless-piping couplings; and coupled joints.

3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
4. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.
- C. Aboveground, soil and waste piping NPS 5 and larger shall be the following:
 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 2. Hubless, cast-iron soil pipe and fittings hubless-piping couplings; and coupled joints.
- D. Aboveground, vent piping NPS 4 and smaller shall be the following:
 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 2. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
 3. Copper Type DWV tube, copper drainage fittings, and soldered joints.
 - a. Option for Vent Piping, NPS 2-1/2 and NPS 3-1/2: Hard copper tube, Type M; copper pressure fittings; and soldered joints.
 4. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 5. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
 6. Galvanized-steel pipe, drainage fittings, and threaded joints.
- E. Underground, soil, waste, and vent piping NPS 6 and smaller shall be the following:
 1. Solid wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 2. Dissimilar Pipe-Material Couplings: Shielded, non-pressure transition couplings.

END OF SECTION

SECTION 22 13 19

SANITARY WASTE PIPING SPECIALTIES

PART 1 GENERAL

3.01 RELATED DOCUMENTS

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

3.02 SUMMARY

- A. Section Includes:
 - 1. Backwater valves.
 - 2. Cleanouts.
 - 3. Air-admittance valves.
 - 4. Miscellaneous sanitary drainage piping specialties.

3.03 DEFINITIONS

- A. ABS: Acrylonitrile butadiene styrene.
- B. PVC: Polyvinyl chloride.

3.04 REFERENCE STANDARDS

- A. ASME A112.6.4 - Roof, Deck, and Balcony Drains; 2022.
- B. ASME A112.14.1 - Backwater Valves; 2003 (Reaffirmed 2022).
- C. ASSE 1072 - Performance Requirements for Barrier Type Floor Drain Trap Seal Protection Devices; 2025, with Editorial Revision.
- D. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings; 2026.
- E. ASTM C564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings; 2026.
- F. NSF 14 - Plastics Piping System Components and Related Materials; 2025.

3.05 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
 - 1. Show fabrication and installation details for frost-resistant vent terminals.

3.06 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

3.07 CLOSEOUT SUBMITTALS

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

PART 2 PRODUCTS

4.01 ASSEMBLY DESCRIPTIONS

- A. Sanitary waste piping specialties shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14 for plastic sanitary waste piping specialty components.

4.02 BACKWATER VALVES

- A. Horizontal, Cast-Iron Backwater Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

-
- a. Jay R. Smith Mfg Co; a division of Morris Group International.
 - b. Josam Company.
 - c. MIFAB, Inc.
 - d. WATTS.
 - e. Zurn Industries, LLC.
 2. Standard: ASME A112.14.1.
 3. Size: Same as connected piping.
 4. Body: Cast iron.
 5. Cover: Cast iron with bolted access check valve.
 6. End Connections: Hub and spigot or hubless.
 7. Type Check Valve: Removable, bronze, swing check, factory assembled or field modified to hang open for airflow unless subject to backflow condition.
 8. Extension: ASTM A74, Service Class; full-size, cast-iron, soil-pipe extension to field-installed cleanout at floor; replaces backwater valve cover.
- B. Drain-Outlet Backwater Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Jay R. Smith Mfg Co; a division of Morris Group International.
 - b. Josam Company.
 - c. WATTS.
 - d. Zurn Industries, LLC.
 2. Size: Same as floor drain outlet.
 3. Body: Cast iron or bronze; made for vertical installation in bottom outlet of floor drain.
 4. Check Valve: Removable ball float.
 5. Inlet: Threaded.
 6. Outlet: Threaded or spigot.
- C. Horizontal, Plastic Backwater Valves :
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Canplas LLC.
 - b. IPS Corporation.
 - c. NDS Inc.
 - d. Oatey.
 - e. Plastic Oddities.
 - f. Sioux Chief Manufacturing Company, Inc.
 - g. Zurn Industries, LLC.
 2. Size: Same as connected piping.
 3. Body: PVC.
 4. Cover: Same material as body with threaded access to check valve.
 5. Check Valve: Removable swing check.
 6. End Connections: Socket type.

4.03 CLEANOUTS

- A. Cast-Iron Exposed Cleanouts:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Jay R. Smith Mfg Co; a division of Morris Group International.
 - b. Josam Company.
 - c. MIFAB, Inc.
 - d. Tyler Pipe; a subsidiary of McWane Inc.

- e. WATTS.
 - f. Zurn Industries, LLC.
 - 2. Standard: ASME A112.36.2M.
 - 3. Size: Same as connected drainage piping
 - 4. Body Material: cast-iron soil pipe T-branch as required to match connected piping.
 - 5. Closure: Countersunk, cast-iron plug.
 - 6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
- B. Cast-Iron Wall Cleanouts ???Insert drawing designation, if any???:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Jay R. Smith Mfg Co; a division of Morris Group International.
 - b. Josam Company.
 - c. MIFAB, Inc.
 - d. WATTS.
 - e. Zurn Industries, LLC.
 - 2. Standard: ASME A112.36.2M. Include wall access.
 - 3. Size: Same as connected drainage piping.
 - 4. Body: Hub-and-spigot, cast-iron soil pipe T-branch as required to match connected piping.
 - 5. Closure Plug:
 - a. Brass.
 - b. Countersunk head.
 - c. Drilled and threaded for cover attachment screw.
 - d. Size: Same as or not more than one size smaller than cleanout size.
 - 6. Wall Access, Cover Plate: Round, deep, chrome-plated bronze cover plate with screw.
 - 7. Wall Access, Frame and Cover: Round nickel-bronze, copper-alloy, or stainless steel wall-installation frame and cover.

4.04 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

- A. Open Drains:
- 1. Description: Shop or field fabricate from ASTM A74, Service Class, hub-and-spigot, cast-iron soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C564 rubber gaskets.
 - 2. Size: Same as connected waste piping[with increaser fitting of size indicated.
- B. Deep-Seal Traps:
- 1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
 - 2. Size: Same as connected waste piping.
 - a. NPS 2: 4-inch-minimum water seal.
 - b. NPS 2-1/2 and Larger: 5-inch-minimum water seal.
- C. Floor-Drain, Trap-Seal Primer Fittings:
- 1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
 - 2. Size: Same as floor drain outlet with NPS 1/2 side inlet.
- D. Floor-Drain, Inline Trap Seal:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Jay R. Smith Mfg Co; a division of Morris Group International.
 - b. Josam Company.
 - c. MIFAB, Inc.
 - d. RectorSeal Plumbing; A CSW Industrials Company.

2. Description: Inline floor drain trap seal, forming a physical barrier to slow trap evaporation while not impeding flow from drain.
 3. Material: Polymer.
 4. Standard: Tested and certified in accordance with ASSE 1072.
 5. Listing: ICC-ES or IAPMO listed.
 6. Size: Same as floor drain outlet or strainer throat.
- E. Stack Flashing Fittings:
1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
 2. Size: Same as connected stack vent or vent stack.
- F. Vent Caps:
1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.
 2. Size: Same as connected stack vent or vent stack.
- G. Frost-Resistant Vent Terminals:
1. Description: Manufactured or shop-fabricated assembly constructed of copper, lead-coated copper, or galvanized steel.
 2. Design: To provide 1-inch enclosed air space between outside of pipe and inside of flashing collar extension, with counterflashing.
- H. Expansion Joints:
1. Standard: ASME A112.6.4.
 2. Body: Cast iron with bronze sleeve, packing, and gland.
 3. End Connections: Matching connected piping.
 4. Size: Same as connected soil, waste, or vent piping.

PART 3 EXECUTION

5.01 INSTALLATION

- A. Install backwater valves in building drain piping.
1. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.
- B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
 2. Locate at each change in direction of piping greater than 45 degrees.
 3. Locate at minimum intervals of 50 feet (1524 cm) for piping NPS 4 and smaller and 100 feet (3048 cm) for larger piping.
 4. Locate at base of each vertical soil and waste stack.
- C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- E. Install fixture air-admittance valves on fixture drain piping.
- F. Install stack air-admittance valves at top of stack vent and vent stack piping.
- G. Install air-admittance-valve wall boxes recessed in wall.
- H. Assemble open drain fittings and install with top of hub 1 inch above floor.
- I. Install deep-seal traps on floor drains and other waste outlets, if indicated.

- J. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
 - 1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
 - 2. Size: Same as floor drain inlet.
- K. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
- L. Install sleeve and sleeve seals with each riser and stack passing through floors with waterproof membrane.
- M. Install vent caps on each vent pipe passing through roof.
- N. Install frost-resistant vent terminals on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.
- O. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.
- P. Install frost-proof vent caps on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.
- Q. Install wood-blocking reinforcement for wall-mounting-type specialties.
- R. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

5.02 PIPING CONNECTIONS

- A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment, to allow service and maintenance.

5.03 LABELING AND IDENTIFYING

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

5.04 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION

SECTION 22 13 19.13

SANITARY DRAINS

PART 1 GENERAL

3.01 RELATED DOCUMENTS

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

3.02 SUMMARY

- A. Section Includes:
 - 1. Floor drains.
 - 2. Floor sinks.
 - 3. Trench drains.
 - 4. Channel drainage systems.

3.03 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene styrene.
- B. FRP: Fiberglass-reinforced plastic.
- C. HDPE: High-density polyethylene.
- D. PE: Polyethylene.
- E. PP: Polypropylene.
- F. PVC: Polyvinyl chloride.

3.04 REFERENCE STANDARDS

- A. ASME A112.3.1 - Stainless Steel Drainage Systems for Sanitary DWV, Storm, and Vacuum Applications Above and Below Ground; 2007 (Reaffirmed 2022).
- B. ASME A112.6.3 - Floor Drains; 2022.
- C. ASME A112.6.7 - Sanitary Floor Sinks; 2022.
- D. NSF 14 - Plastics Piping System Components and Related Materials; 2025.

3.05 ACTION SUBMITTALS

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

PART 2 PRODUCTS

4.01 DRAIN ASSEMBLIES

- A. Sanitary drains shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14 for plastic sanitary piping specialty components.

4.02 FLOOR DRAINS

- A. Cast-Iron Floor Drains :
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Jay R. Smith Mfg Co; a division of Morris Group International.
 - b. Josam Company.
 - c. MIFAB, Inc.
 - d. Prier Products, Inc.
 - e. Sioux Chief Manufacturing Company, Inc.
 - f. Wade; a subsidiary of McWane Inc.
 - g. WATTS.

- h. Zurn Industries, LLC.
2. Standard: ASME A112.6.3.
3. Pattern: Floor drain.
4. Body Material: Gray iron .
5. Seepage Flange: Required.
6. Anchor Flange: Required.
7. Outlet: Bottom.
8. Coating on Interior and Exposed Exterior Surfaces: Acid-resistant enamel .
9. Sediment Bucket: Not required .
10. Top or Strainer Material: Nickel bronze.
11. Top of Body and Strainer Finish: Nickel bronze.
12. Top Shape: Square.

4.03 FLOOR SINKS

A. Cast-Iron Floor Sinks:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Commercial Enameling Company.
 - b. Jay R. Smith Mfg Co; a division of Morris Group International.
 - c. Josam Company.
 - d. Wade; a subsidiary of McWane Inc.
 - e. WATTS.
 - f. Zurn Industries, LLC.
2. Standard: ASME A112.6.7.
3. Pattern: Floor drain.
4. Body Material: Cast iron.
5. Anchor Flange: Required, with seepage holes.
6. Outlet: Bottom, no-hub connection.
7. Coating on Interior Surfaces: Acid-resistant enamel .
8. Sediment Bucket: Required.
9. Internal Strainer: Not required.
10. Internal Strainer Material: Aluminum.
11. Top Grate Material: Cast iron, hinged.
12. Top of Body and Grate Finish: Acid-resistant enamel .
13. Top Shape: Square.
14. Top Loading Classification: No traffic loading.

PART 3 EXECUTION

5.01 INSTALLATION

- A. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
 1. Position floor drains for easy access and maintenance.
 2. Set floor drains below elevation of surrounding finished floor to allow floor drainage.
 3. Set with grates depressed according to the following drainage area radii:
 - a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
 - b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
 - c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
 4. Install floor-drain flashing collar or flange, so no leakage occurs between drain and adjoining flooring.

- a. Maintain integrity of waterproof membranes where penetrated.
- 5. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
- B. Install trench drains at low points of surface areas to be drained.
 - 1. Set grates of drains flush with finished surface, unless otherwise indicated.
- C. Comply with ASME A112.3.1 for installation of stainless-steel channel drainage systems.
 - 1. Install on support devices, so that top will be flush with adjacent surface.
- D. Install open drain fittings with top of hub 1 inch (25.4 mm) above floor.

5.02 CONNECTIONS

- A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Comply with requirements in Section 221319 "Sanitary Waste Piping Specialties" for backwater valves, air admittance devices and miscellaneous sanitary drainage piping specialties.
- C. Comply with requirements in Section 221323 "Sanitary Waste Interceptors" for grease interceptors, grease-removal devices, oil interceptors, sand interceptors, and solid interceptors.
- D. Install piping adjacent to equipment to allow service and maintenance.
- E. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- F. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

5.03 LABELING AND IDENTIFYING

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

5.04 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION

SECTION 22 13 23

SANITARY WASTE INTERCEPTORS

PART 1 GENERAL

3.01 RELATED DOCUMENTS

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

3.02 SUMMARY

- A. Section Includes:
 - 1. Grease interceptors.
 - 2. Grease-removal devices.

3.03 DEFINITIONS

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

3.04 REFERENCE STANDARDS

- A. ASTM A48/A48M - Standard Specification for Gray Iron Castings; 2022.
- B. ASTM A536 - Standard Specification for Ductile Iron Castings; 2024.
- C. ASTM C891 - Standard Practice for Installation of Underground Precast Concrete Utility Structures; 2020.
- D. ASTM C913 - Standard Specification for Precast Concrete Water and Wastewater Structures; 2023.

3.05 ACTION SUBMITTALS

- A. Product Data: For each type of interceptor. Include materials of fabrication, dimensions, rated capacities, retention capacities, operating characteristics, size and location of each pipe connection, furnished specialties, and accessories.
- B. Shop Drawings: For each type and size of precast-concrete interceptor indicated.
 - 1. Include materials of construction, dimensions, rated capacities, retention capacities, location and size of each pipe connection, furnished specialties, and accessories.

3.06 INFORMATIONAL SUBMITTALS

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

3.07 CLOSEOUT SUBMITTALS

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

PART 2 PRODUCTS

4.01 GREASE INTERCEPTORS

- A. Precast-Concrete Grease Interceptors: Comply with ASTM C913 .
 - 1. Include rubber-gasketed joints, vent connections, manholes, compartments or baffles, and piping or openings to retain grease and to permit wastewater flow.
 - 2. Structural Design Loads:
 - a. Light-Traffic Load: Comply with ASTM C890, A-8.
 - b. Medium-Traffic Load: Comply with ASTM C890, A-12.

- c. Heavy-Traffic Load: Comply with ASTM C890, A-16.
- d. Walkway Load: Comply with ASTM C890, A-03.
- 3. Resilient Pipe Connectors: ASTM C923 (ASTM C923M), cast or fitted into interceptor walls, for each pipe connection.
- 4. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, to match diameter of manhole frame and cover.
- 5. Manhole Frames and Covers: Ferrous; 24-inch ID by 7- to 9-inch riser with 4-inch-minimum-width flange and 26-inch diameter cover.
 - a. Ductile Iron: ASTM A536, Grade 60-40-18, unless otherwise indicated.
 - b. Gray Iron: ASTM A48/A48M, Class 35, unless otherwise indicated.
 - c. Include indented top design with lettering cast into cover, using wording equivalent to GREASE INTERCEPTOR ."

PART 3 EXECUTION

5.01 EARTHWORK

- A. Excavating, trenching, and backfilling are specified in Section 312000 "Earth Moving."

5.02 INSTALLATION

- A. Equipment Mounting:
 - 1. Install grease interceptors on cast-in-place concrete equipment base(s).
 - 2. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
- B. Install precast concrete interceptors according to ASTM C891.
- C. Set interceptors level and plumb.
- D. Install manhole risers from top of underground concrete interceptors to manholes and gratings at finished grade.
- E. Set tops of manhole frames and covers flush with finished surface in pavements.

5.03 PIPING CONNECTIONS

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

5.04 IDENTIFICATION

- A. Identification materials and installation are specified in Section 312000 "Earth Moving."
 - 1. Arrange for installation of green warning tapes directly over piping and at outside edges of underground interceptors.
 - 2. Use warning tapes or detectable warning tape over ferrous piping.
 - 3. Use detectable warning tape over nonferrous piping and over edges of underground structures.
- B. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
 - 1. Grease interceptors.

5.05 PROTECTION

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

END OF SECTION

22 14 13

FACILITY STORM DRAINAGE PIPING

PART 1 GENERAL

3.01 REFERENCE STANDARDS

- A. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250; 2026.
- B. ASME B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges; 2021.
- C. ASME B18.2.1 - Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series); 2012 (Reaffirmed 2021).
- D. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings; 1999, with Editorial Revision (2022).
- E. ASTM A48/A48M - Standard Specification for Gray Iron Castings; 2022.
- F. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2024.
- G. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings; 2026.
- H. ASTM A106/A106M - Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service; 2026.
- I. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2025.
- J. ASTM A536 - Standard Specification for Ductile Iron Castings; 2024.
- K. ASTM A674 - Standard Practice for Polyethylene Encasement for Ductile Iron Pipe; 2022.
- L. ASTM B29 - Standard Specification for Refined Lead; 2019 (Reapproved 2025).
- M. ASTM C564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings; 2026.
- N. ASTM C1277 - Standard Specification for Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings; 2020.
- O. ASTM C1540 - Standard Specification for Heavy-Duty Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings; 2020.
- P. ASTM D2235 - Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings; 2022.
- Q. ASTM D2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems; 2020 (Reapproved 2024).
- R. ASTM D2661 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings; 2024.
- S. ASTM D2665 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings; 2025.
- T. 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 (Reapproved 2024).
- U. ASTM D3311 - Standard Specification for Drain, Waste, and Vent (DWV) Plastic Fittings Patterns; 2022 .
- V. ASTM F402 - Standard Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings; 2026.

- W. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe; 2014 (Reapproved 2021).
- X. ASTM F656 - Standard Specification for Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) and Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings; 2025.
- Y. ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications; 2007 (Reapproved 2024).
- Z. AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Pipe Systems; 2018.
- AA. AWWA C606 - Grooved and Shouldered Joints; 2022.
- BB. CISPI 301 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications; 2021.
- CC. CISPI 310 - Specification for Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications; 2020.
- DD. NSF 14 - Plastics Piping System Components and Related Materials; 2025.

3.02 RELATED DOCUMENTS

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

3.03 SUMMARY

- A. Section Includes:
 - 1. Hub-and-spigot, cast-iron soil pipe and fittings.
 - 2. Hubless, cast-iron soil pipe and fittings.
 - 3. PVC pipe and fittings.
 - 4. Specialty pipe and fittings.
 - 5. Encasement for underground metal piping.

3.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Sustainable Design Submittals:
- C. Shop Drawings: For[siphonic roof drainage system. Include calculations, plans, and details.

3.05 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Detail storm drainage piping. Show support locations, type of support, weight on each support, required clearances, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Structural members to which drainage piping will be attached or suspended from.
- B. Field quality-control reports.

3.06 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

PART 2 PRODUCTS

4.01 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
 - 1. Storm Drainage Piping: 10-foot head of water .

4.02 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. AB & I Foundry; a part of the McWane family of companies.
 - 2. Charlotte Pipe and Foundry Company.
 - 3. NewAge Casting.
 - 4. Tyler Pipe; a part of McWane family of companies.
- B. Pipe and Fittings:
 - 1. Marked with CISPI collective trademark and NSF certification mark.
 - 2. Class: ASTM A74, Service class(es).
- C. Gaskets: ASTM C564, rubber.
- D. Caulking Materials: ASTM B29, pure lead and oakum or hemp fiber.

4.03 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. AB & I Foundry; a part of the McWane family of companies.
 - 2. Charlotte Pipe and Foundry Company.
 - 3. NewAge Casting.
 - 4. Tyler Pipe; a part of McWane family of companies.
- B. Pipe and Fittings:
 - 1. Marked with CISPI collective trademark and NSF certification mark.
 - 2. Standard: ASTM A 888 or CISPI 301.
- C. CISPI, Hubless-Piping Couplings:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ANACO-Husky.
 - b. Charlotte Pipe and Foundry Company.
 - c. Dallas Specialty & Mfg. Co.
 - d. Fernco Inc.
 - e. Ideal Clamp Products, Inc.
 - f. Matco-Norca.
 - g. MIFAB, Inc.
 - h. Mission Rubber Company, LLC; a division of MCP Industries.
 - i. NewAge Casting.
 - j. Tyler Pipe; a subsidiary of McWane Inc.
 - 2. Couplings shall bear CISPI collective trademark and NSF certification mark.
 - 3. Standards: ASTM C1277 and CISPI 310. ???Insert standard???
 - 4. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.
- D. Heavy-Duty, Hubless-Piping Couplings:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ANACO-Husky.
 - b. Charlotte Pipe and Foundry Company.
 - c. Clamp-All Corp.
 - d. Dallas Specialty & Mfg. Co.
 - e. Ideal Clamp Products, Inc.
 - f. MIFAB, Inc.

- g. Mission Rubber Company, LLC; a division of MCP Industries.
 - h. NewAge Casting.
 - i. Tyler Pipe; a subsidiary of McWane Inc.
- 2. Standard: ASTM C1540. ???Insert standard???
- 3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.
- E. Cast-Iron, Hubless-Piping Couplings:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Charlotte Pipe and Foundry Company.
 - b. MG Piping Products Company.
 - 2. Standard: ASTM C1277. ???Insert standard???
 - 3. Description: Two-piece ASTM A48/A48M, cast-iron housing; stainless-steel bolts and nuts; and ASTM C564, rubber sleeve with integral, center pipe stop.
- F. Cast-Iron Flanges: ASME B16.1, Class 125.
 - 1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
 - 2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- G. Grooved-Joint, Galvanized-Steel-Pipe Appurtenances
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International.
 - b. Grinnell G-Fire by Johnson Controls Company.
 - c. Shurjoint-Apollo Piping Products USA Inc.
 - d. Smith-Cooper International.
 - e. Victaulic Company.
 - 2. Galvanized, Grooved-End Fittings for Galvanized-Steel Piping: ASTM A536 ductile-iron castings, ASTM A47/A47M malleable-iron castings, ASTM A234/A234M forged-steel fittings, or ASTM A106/A106M steel pipes with dimensions matching ASTM A53/A53M steel pipe, and complying with AWWA C606 for grooved ends.
 - 3. Grooved Mechanical Couplings for Galvanized-Steel Piping: ASTM F1476, Type I. Include ferrous housing sections with continuous curved keys; EPDM-rubber gasket suitable for hot and cold water; and bolts and nuts.

4.04 PVC PIPE AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Charlotte Pipe and Foundry Company.
 - 2. GF Piping Systems.
 - 3. JM Eagle; J-M Manufacturing Co., Inc.
 - 4. Mueller Industries, Inc.
 - 5. National Pipe and Plastic, Inc.
 - 6. North America Pipe Corporation.
 - 7. Rocky Mountain Colby Pipe Company.
 - 8. Silver-line Plastics.
- B. NSF Marking: Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic storm drain and "NSF-sewer" for plastic storm sewer piping.
- C. Solid-Wall PVC Pipe: ASTM D2665; drain, waste, and vent.
- D. Cellular-Core PVC Pipe: ASTM F 891, Schedule 40.

- E. PVC Socket Fittings: ASTM D2665, made to ASTM D3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
- F. Adhesive Primer: ASTM F656.
- G. Solvent Cement: ASTM D2564.

4.05 SPECIALTY PIPE FITTINGS

- A. Transition Couplings:
 - 1. General Requirements: Fitting or device for joining piping with small differences in ODs or of different materials. Include end connections same size as and compatible with pipes to be joined.
 - 2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified-piping-system fitting.
 - 3. Unshielded, Nonpressure Transition Couplings:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Dallas Specialty & Mfg. Co.
 - 2) Fernco Inc.
 - 3) Mission Rubber Company, LLC; a division of MCP Industries.
 - 4) Plastic Oddities.
 - b. Standard: ASTM C 1173.
 - c. Description: Elastomeric sleeve, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - d. Sleeve Materials:
 - 1) For Cast-Iron Soil Pipes: ASTM C564, rubber.
 - 2) For Plastic Pipes: ASTM F477, elastomeric seal or ASTM D 5926, PVC.
 - 3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
 - 4. Shielded, Nonpressure Transition Couplings:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Cascade Waterworks Mfg. Co.
 - 2) Mission Rubber Company, LLC; a division of MCP Industries.
 - b. Standard: ASTM C 1460.
 - c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - d. End Connections: Same size as and compatible with pipes to be joined.
- B. Dielectric Fittings:
 - 1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
 - 2. Dielectric Unions:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) A.Y. McDonald Mfg. Co.
 - 2) Capitol Manufacturing Company.
 - 3) Central Plastics Company.
 - 4) HART Industrial Unions, LLC.
 - 5) Jomar Valve.
 - 6) Matco-Norca.
 - 7) WATTS.

-
- 8) Zurn Industries, LLC.
 - b. Description:
 - 1) Standard: ASSE 1079.
 - 2) Pressure Rating: 150 psig (1034.21 kPa) minimum at 180 deg F.
 - 3) End Connections: Solder-joint copper alloy and threaded ferrous.
 - 3. Dielectric Flanges:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Central Plastics Company.
 - 2) Matco-Norca.
 - 3) WATTS.
 - 4) Zurn Industries, LLC.
 - b. Description:
 - 1) Standard: ASSE 1079.
 - 2) Factory-fabricated, bolted, companion-flange assembly.
 - 3) Pressure Rating: 150 psig (1034.21 kPa) minimum at 180 deg F.
 - 4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
 - 4. Dielectric-Flange Insulating Kits:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Advance Products & Systems, Inc.
 - 2) Calpico, Inc.
 - 3) Central Plastics Company.
 - 4) GPT; an EnPro Industries company.
 - b. Description:
 - 1) Nonconducting materials for field assembly of companion flanges.
 - 2) Pressure Rating: 150 psig (1034.21 kPa).
 - 3) Gasket: Neoprene or phenolic.
 - 4) Bolt Sleeves: Phenolic or polyethylene.
 - 5) Washers: Phenolic with steel-backing washers.

PART 3 EXECUTION

5.01 EARTH MOVING

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

5.02 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.
 - 1. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
 - 2. Install piping as indicated unless deviations from layout are approved on coordination drawings.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.
- J. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- K. Make changes in direction for piping using appropriate branches, bends, and long-sweep bends.
 - 1. Do not change direction of flow more than 90 degrees.
 - 2. Use proper size of standard increasers and reducers if pipes of different sizes are connected.
 - a. Reducing size of drainage piping in direction of flow is prohibited.
- L. Lay buried building piping beginning at low point of each system.
 - 1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
 - 2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
 - 3. Maintain swab in piping and pull past each joint as completed.
- M. Install piping at the following minimum slopes unless otherwise indicated:
 - 1. Building Storm Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
- N. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
 - 1. Install encasement on underground piping according to ASTM A674 or AWWA C105/A21.5.
- O. Install steel piping according to applicable plumbing code.
- P. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."
- Q. Install aboveground ABS piping according to ASTM D2661.
- R. Install aboveground PVC piping according to ASTM D2665.
- S. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- T. Install sleeves for piping penetrations of walls, ceilings, and floors.
 - 1. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- U. Install sleeve seals for piping penetrations of concrete walls and slabs.
 - 1. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- V. Install escutcheons for piping penetrations of walls, ceilings, and floors.
 - 1. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

5.03 JOINT CONSTRUCTION

- A. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

- B. Hub-and-Spigot, Cast-Iron Soil Piping Caulked Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum caulked joints.
- C. Hubless, Cast-Iron Soil Piping Coupled Joints:
 - 1. Join according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.
- D. Plastic, Non-pressure-Piping, Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. ABS Piping: Join according to ASTM D2235 and ASTM D2661 appendices.
 - 3. PVC Piping: Join according to ASTM D2855 and ASTM D2665 appendices.

5.04 INSTALLATION OF HANGERS AND SUPPORTS

- A. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Comply with requirements for hangers, supports, and anchor devices specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
 - 1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
 - 2. Vertical Piping: MSS Type 8 or Type 42, clamps.
 - 3. Install individual, straight, horizontal piping runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
- C. Install hangers for cast-iron piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- D. Install hangers for PVC piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- E. Support horizontal piping and tubing within 12 inches (304.8 mm) of each fitting and coupling.
- F. Support vertical cast-iron piping to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent, but as a minimum at base and at each floor.
- G. Support vertical PVC piping with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

5.05 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect storm drainage piping to roof drains and storm drainage specialties.
 - 1. Install test tees (wall cleanouts) in conductors near floor, and floor cleanouts with cover flush with floor.

5.06 IDENTIFICATION

- A. Identify exposed storm drainage piping.
- B. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

5.07 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 - 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
 - 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.
 - a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - 2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved.
 - a. Expose work that was covered or concealed before it was tested.
 - 3. Test Procedure:
 - a. Test storm drainage piping, except outside leaders, on completion of roughing-in.
 - b. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts until completion of inspection, water level must not drop. Inspect joints for leaks.
 - 4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 - 5. Prepare reports for tests and required corrective action.
- C. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - 1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved.
 - a. Expose work that was covered or concealed before it was tested.
 - 2. Cap and subject piping to static-water pressure of 50 psig (344.74 kPa) above operating pressure, without exceeding pressure rating of piping system materials.
 - a. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 - 3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 - 4. Prepare reports for tests and required corrective action.
- D. Piping will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

5.08 CLEANING AND PROTECTION

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

5.09 PIPING SCHEDULE

- A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- B. Aboveground storm drainage piping NPS 6 and smaller shall be any of the following:
 - 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.

2. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
 3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 4. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.
- C. Aboveground, storm drainage piping NPS 8 and larger shall be any of the following:
1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 2. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
 3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
- D. Underground storm drainage piping NPS 6 and smaller any of the following:
1. Extra Heavy class, cast-iron soil pipe and fittings; and caulked joints.
 2. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
- E. Underground, storm drainage piping NPS 8 and larger shall be the following:
1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 2. Cellular-core, sewer and drain series, PVC pipe; PVC socket fittings; and solvent-cemented joints.

END OF SECTION

22 33 00

ELECTRIC, DOMESTIC - WATER HEATERS

PART 1 GENERAL

3.01 REFERENCE STANDARDS

- A. ANSI Z21.22 - American National Standard for Relief Valves for Hot Water Supply Systems; 2015 (Reaffirmed 2025).
- B. ASME B1.20.1 - Pipe Threads, General Purpose, Inch; 2013 (Reaffirmed 2018).
- C. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24 Metric/Inch Standard; 2025.
- D. ASME B16.24 - Cast Copper Alloy Pipe Flanges, Flanged Fittings, and Valves: Classes 150, 300, 600, 900, 1500, and 2500; 2021.
- E. ASSE 1003 - Water Pressure Reducing Valves for Potable Water Distribution Systems; 2023.
- F. ASSE 1010 - Performance Requirements for Water Hammer Arresters; 2025.
- G. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- H. NSF 5 - Water Heaters, Hot Water Supply Boilers, and Heat Recovery Equipment; 2024.
- I. NSF 61 - Drinking Water System Components - Health Effects; 2025, with Addendum
- J. NSF 372 - Drinking Water System Components - Lead Content; 2024.
- K. PDI-WH 201 - Water Hammer Arresters; 2017.
- L. UL 174 - Standard for Household Electric Storage Tank Water Heaters; Current Edition, Including All Revisions.
- M. UL 1453 - Standard for Electric Booster and Commercial Storage Tank Water Heaters; Current Edition, Including All Revisions.

3.02 RELATED DOCUMENTS

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

3.03 SUMMARY

- A. Section Includes:
 - 1. Commercial, electric, storage, domestic-water heaters.
 - 2. Commercial, light-duty, storage, electric, domestic-water heaters.
 - 3. Domestic-water heater accessories.

3.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Sustainable Design Submittals:
- C. Shop Drawings:
 - 1. Include diagrams for power, signal, and control wiring.

3.05 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Equipment room drawing or BIM model, drawn to scale, on which the items described in this Section are shown and coordinated with all building trades.

- B. Seismic Qualification Data: Certificates, for commercial domestic-water heaters, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Product Certificates: For each type of commercial, electric, domestic-water heater.
- D. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.
- E. Source quality-control reports.
- F. Field quality-control reports.
- G. Sample Warranty: For special warranty.

3.06 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For electric, domestic-water heaters to include emergency, operation, and maintenance manuals.

3.07 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

3.08 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of electric, domestic-water heaters that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including storage tank and supports.
 - b. Faulty operation of controls.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal use.
 - 2. Warranty Periods: From date of Substantial Completion.
 - a. Commercial, Electric, Domestic-Water Booster Heaters:
 - 1) Controls and Other Components Five years.
 - b. Commercial, Light-Duty, Storage, Electric, Domestic-Water Heaters:
 - 1) Storage Tank: Five years.
 - 2) Controls and Other Components: Three years.
 - c. Expansion Tanks: Five years.

PART 2 PRODUCTS

4.01 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.
- B. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.
- C. ASME Compliance: Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 and NSF 372.

4.02 COMMERCIAL, ELECTRIC, DOMESTIC-WATER HEATERS

- A. Commercial, Electric, Domestic-Water Booster Heaters:

-
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. A. O. Smith Corporation.
 - b. Electric Heater Company (The).
 - c. Bradford White.
 - d. Lochinvar, LLC.
 - e. Rheem Manufacturing Company.
 - f. Ruud Water Heaters; a Rheem brand.
 2. Source Limitations: Obtain domestic-water booster heaters from single source from single manufacturer.
 3. Standard: UL 1453.
 4. Tank Construction: steel.
 - a. Tappings: ASME B1.20.1 pipe thread.
 - b. Pressure Rating: 150 psig (1034.21 kPa).
 - c. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending lining material into tappings.
 5. Factory-Installed Tank Appurtenances:
 - a. Anode Rod: Replaceable magnesium.
 - b. Drain Valve: Corrosion-resistant metal with hose-end connection.
 - c. Insulation: Comply with ASHRAE/IES 90.1.
 - d. Jacket: Rectangular shaped, with stainless steel front panel, unless otherwise indicated.
 - e. Heating Elements: Electric, screw-in or bolt-on immersion type arranged in multiples of three.
 - 1) Option: Booster heaters with total of 9 kW or less may have one, two, or three elements.
 - f. Temperature Control: Adjustable thermostat, to setting of at least 180 deg F (82 deg C).
 - g. Safety Controls: High-temperature-limit and low-water cutoff devices or systems.
 - h. Relief Valve: ASME rated and stamped for combination temperature-and-pressure relief valve. Include relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of domestic-water heater. Select relief valve with sensing element that extends into storage tank.
 - i. Gauges: Combination temperature-and-pressure type or separate thermometer and pressure gauge.
 6. Special Requirements: NSF 5 construction with brackets for undercounter installation.
- B. Commercial, Electric, Storage, Domestic-Water Heaters:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. A. O. Smith Corporation.
 - b. American Water Heaters.
 - c. Bradford White Corporation.
 - d. Lochinvar, LLC.
 - e. PVI; A WATTS Brand.
 - f. Rheem Manufacturing Company.
 - g. State Industries.
 2. Source Limitations: Obtain domestic-water heaters from single source from single manufacturer.
 3. Standard: UL 1453.
 4. Storage-Tank Construction: ASME-code, steel vertical arrangement.

-
- a. Tappings: Factory fabricated of materials compatible with tank and piping connections. Attach tappings to tank before testing.
 - 1) NPS 2 and Smaller: Threaded ends in accordance with ASME B1.20.1.
 - 2) NPS 2-1/2 and Larger: Flanged ends in accordance with ASME B16.5 for steel and stainless steel flanges, and in accordance with ASME B16.24 for copper and copper-alloy flanges.
 - b. Pressure Rating: 150 psig (1034.21 kPa).
 - c. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending lining material into tappings.
 - 5. Factory-Installed, Storage-Tank Appurtenances:
 - a. Anode Rod: Replaceable magnesium.
 - b. Drain Valve: Corrosion-resistant metal with hose-end connection.
 - c. Insulation: Comply with ASHRAE/IES 90.1.
 - d. Jacket: Steel with enameled finish or high-impact composite material.
 - e. Heating Elements: Electric, screw-in or bolt-on immersion type arranged in multiples of three.
 - f. Temperature Control: Adjustable thermostat.
 - g. Safety Controls: High-temperature-limit and low-water cutoff devices or systems.
 - h. Relief Valves: ASME rated and stamped for combination temperature-and-pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of domestic-water heater. Select one relief valve with sensing element that extends into storage tank.
 - 6. Special Requirements: NSF 5 construction.
- C. Commercial, Light-Duty, Storage, Electric, Domestic-Water Heaters:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. A. O. Smith Corporation.
 - b. American Water Heaters.
 - c. Bradford White Corporation.
 - d. Heat Transfer Products, Inc.
 - e. Hubbell Electric Heater Co.
 - f. Lochinvar, LLC.
 - g. Rheem Manufacturing Company.
 - h. State Industries.
 - 2. Source Limitations: Obtain domestic-water heaters from single source from single manufacturer.
 - 3. Standard: UL 174.
 - 4. Storage-Tank Construction: Steel, vertical arrangement.
 - a. Tappings: ASME B1.20.1 pipe thread.
 - b. Pressure Rating: 150 psig (1034.21 kPa).
 - c. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending lining material into tappings.
 - 5. Factory-Installed, Storage-Tank Appurtenances:
 - a. Anode Rod: Replaceable magnesium.
 - b. Dip Tube: Required unless cold-water inlet is near bottom of tank.
 - c. Drain Valve: Corrosion-resistant metal with hose-end connection.
 - d. Insulation: Comply with ASHRAE/IES 90.1.
 - e. Jacket: Steel with enameled finish or high-impact composite material.
 - f. Heat-Trap Fittings: Inlet type in cold-water inlet and outlet type in hot-water outlet.
 - g. Heating Elements: Electric, screw-in immersion type.

- h. Temperature Control: Adjustable thermostat.
 - i. Safety Control: High-temperature-limit cutoff device or system.
 - j. Relief Valve: ASME rated and stamped for combination temperature-and-pressure relief valves. Include relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of domestic-water heater. Select relief valve with sensing element that extends into storage tank.
6. Special Requirements: NSF 5 construction with legs for off-floor installation.

4.03 DOMESTIC-WATER HEATER ACCESSORIES

- A. Domestic-Water Expansion Tanks:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. A. O. Smith Corporation.
 - b. AMTROL, Inc.
 - c. Flexcon Industries.
 - d. Honeywell.
 - e. Pentair Pump Group.
 - f. State Industries.
 - g. TACO Comfort Solutions, Inc.
 - 2. Source Limitations: Obtain domestic-water expansion tanks from single source from single manufacturer.
 - 3. Description: Steel pressure-rated tank constructed with welded joints and factory-installed, butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
 - 4. Construction:
 - a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
 - b. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
 - c. Air-Charging Valve: Factory installed.
- B. Drain Pans: Corrosion-resistant metal with raised edge. Include dimensions not less than base of domestic-water heater, and include drain outlet not less than NPS 3/4 (DN 20) with ASME B1.20.1 pipe threads.
- C. Piping-Type Heat Traps: Field-fabricated piping arrangement in accordance with ASHRAE/IES 90.1
- D. Heat-Trap Fittings: ASHRAE/IES 90.1.
- E. Manifold Kits: Domestic-water-heater manufacturer's factory-fabricated inlet and outlet piping for field installation, for multiple domestic-water heater installation. Include ball-, butterfly-, or gate-type shutoff valves to isolate each domestic-water heater and calibrated balancing valves to provide balanced flow through each domestic-water heater.
- 1. Comply with requirements for ball-, butterfly-, or gate-type shutoff valves specified in Section 220523.12 "Ball Valves for Plumbing Piping," Section 220523.13 "Butterfly Valves for Plumbing Piping," and Section 220523.15 "Gate Valves for Plumbing Piping."
 - 2. Comply with requirements for balancing valves specified in Section 221119 "Domestic Water Piping Specialties."
- F. Pressure-Reducing Valves: ASSE 1003 for water. Set at 25-psig- (172.5-kPa-) maximum outlet pressure unless otherwise indicated.
- G. Combination Temperature-and-Pressure Relief Valves: ASME rated and stamped. Include relieving capacity at least as great as heat input, and include pressure setting less than

working-pressure rating of domestic-water heater. Select relief valves with sensing element that extends into storage tank.

- H. Pressure Relief Valves: ASME rated and stamped. Include pressure setting less than working-pressure rating of domestic-water heater.
- I. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4.
- J. Shock Absorbers: ASSE 1010 or PDI-WH 201, Size A water hammer arrester.
- K. Domestic-Water Heater Stands: Manufacturer's factory-fabricated steel stand for floor mounting, capable of supporting domestic-water heater and water. Include dimension that will support bottom of domestic-water heater a minimum of 18 inches (457.2 mm) above the floor.
- L. Domestic-Water Heater Mounting Brackets: Manufacturer's factory-fabricated steel bracket for wall mounting, capable of supporting domestic-water heater and water.

4.04 SOURCE QUALITY CONTROL

- A. Factory Tests: Test and inspect domestic-water heaters specified to be ASME-code construction, in accordance with ASME Boiler and Pressure Vessel Code.
- B. Hydrostatically test commercial domestic-water heaters to minimum of one and one-half times pressure rating before shipment.
- C. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

PART 3 EXECUTION

5.01 DOMESTIC-WATER HEATER INSTALLATION

- A. Commercial, Electric, Domestic-Water Heater Mounting: Install commercial, electric, domestic-water heaters on concrete base. Comply with requirements for concrete bases specified in Section 033000 "Cast-in-Place Concrete."
 - 1. Exception: Omit concrete bases for commercial, electric, domestic-water heaters if installation on stand, bracket, suspended platform, or directly on floor is indicated.
 - 2. Maintain manufacturer's recommended clearances.
 - 3. Arrange units so controls and devices that require servicing are accessible.
 - 4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
 - 5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 6. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 7. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 8. Anchor domestic-water heaters to substrate.
- B. Install electric, domestic-water heaters level and plumb, in accordance with layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
 - 1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Section 220523.12 "Ball Valves for Plumbing Piping," Section 220523.13 "Butterfly Valves for Plumbing Piping," and Section 220523.15 "Gate Valves for Plumbing Piping."
- C. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend domestic-water heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

- D. Install combination temperature and pressure relief valves in water piping for electric, domestic-water heaters without storage. Extend domestic-water heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- E. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for electric, domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves .
- F. Install thermometers on outlet piping of electric, domestic-water heaters. Comply with requirements for thermometers.
- G. Install thermometers on inlet and outlet piping of residential, solar, electric, domestic-water heaters. Comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Plumbing Piping."
- H. Assemble and install inlet and outlet piping manifold kits for multiple electric, domestic-water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each electric, domestic-water heater. Include shutoff valve and thermometer in each domestic-water heater inlet and outlet, and throttling valve in each electric, domestic-water heater outlet. Comply with requirements for valves specified in Section 220523.12 "Ball Valves for Plumbing Piping and comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Plumbing Piping."
- I. Install piping-type heat traps on inlet and outlet piping of electric, domestic-water heater storage tanks without integral or fitting-type heat traps.
- J. Fill electric, domestic-water heaters with water.
- K. Charge domestic-water expansion tanks with air to required system pressure.
- L. Install dielectric fittings in all locations where piping of dissimilar metals is to be joined. The wetted surface of the dielectric fitting contacted by potable water shall contain less than 0.25 percent of lead by weight.

5.02 PIPING CONNECTIONS

- A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to electric, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

5.03 IDENTIFICATION

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

5.04 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections with the assistance of a factory-authorized service representative.
- E. Tests and Inspections:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

2. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- F. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections.
- G. Prepare test and inspection reports.
- 5.05 DEMONSTRATION
- A. Train Owner's maintenance personnel to adjust, operate, and maintain commercial electric, domestic-water heaters. Training shall be a minimum of one hour(s).

END OF SECTION

SECTION 22 40 00
PLUMBING FIXTURES
PART 1 GENERAL

3.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Coordinate with Commissioning Requirements indicated in Section 019100. This contractor is responsible to comply with all requirements for the above section.

3.02 SUMMARY

- A. This Section includes the following conventional plumbing fixtures and related components:
- B. Faucets for lavatories.
- C. Laminar-flow faucet-spout outlets.
- D. Flushometers.
- E. Toilet seats.
- F. Protective shielding guards.
- G. Fixture supports.
- H. Water closets.
- I. Urinals.
- J. Lavatories.

3.03 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.
- C. Cast Polymer: Cast-filled-polymer-plastic material. This material includes cultured-marble and solid-surface materials.
- D. Cultured Marble: Cast-filled-polymer-plastic material with surface coating.
- E. Fitting: Device that controls the flow of water into or out of the plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads and tub spouts, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.
- F. FRP: Fiberglass-reinforced plastic.
- G. PMMA: Polymethyl methacrylate (acrylic) plastic.
- H. PVC: Polyvinyl chloride plastic.
- I. Solid Surface: Nonporous, homogeneous, cast-polymer-plastic material with heat-, impact-, scratch-, and stain-resistance qualities.

3.04 REFERENCE STANDARDS

- A. ICC A117.1 - Accessible and Usable Buildings and Facilities; 2017.
- B. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- C. NSF 61 - Drinking Water System Components - Health Effects; 2025, with Addendum

3.05 SUBMITTALS

- A. Product Data: For each type of plumbing fixture indicated. Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow-control rates.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Operation and Maintenance Data: For plumbing fixtures to include in emergency, operation, and maintenance manuals.
- D. Warranty: Special warranty specified in this Section.

3.06 QUALITY ASSURANCE

- A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.
- B. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.
- E. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.
- F. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
- G. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

3.07 WARRANTY

- A. Special Warranties: Manufacturer's standard form in which manufacturer agrees to repair or replace components of whirlpools that fail in materials or workmanship within specified warranty period.
- B. Failures include, but are not limited to, the following:
 - 1. Structural failures of unit shell.
 - 2. Faulty operation of controls, blowers, pumps, heaters, and timers.
 - 3. Deterioration of metals, metal finishes, and other materials beyond normal use.

3.08 MAINTENANCE

- A. Provide twelve (12) months maintenance of all materials and equipment under this section. Cost of the twelve (12) month normal and preventive maintenance shall be included within this scope of work.

PART 2 PRODUCTS

4.01 LAVATORY FAUCETS

- A. Lavatory Faucets:
- B. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, the following:
 - 1. Chicago.
 - 2. Delta
 - 3. Symmons.

4. TOTO

- C. Description: Refer to fixture schedule on the Drawings.

4.02 FLUSHOMETERS

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

1. Sloan Valve Company.
2. Zurn Plumbing Products Group; Commercial Brass Operation.
3. Royal.
4. TOTO USA, Inc.

- B. Description: Refer to fixture schedule on the Drawings.

4.03 TOILET SEATS

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

1. American Standard Companies, Inc.
2. Bemis Manufacturing Company.
3. Church Seats.
4. Kohler Co.

- B. Description: Refer to fixture schedule on the Drawings..

4.04 FIXTURE SUPPORTS

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

1. Josam Company.
2. MIFAB Manufacturing Inc.
3. Smith, Jay R. Mfg. Co.
4. Tyler Pipe; Wade Div.
5. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.
6. Zurn Plumbing Products Group; Specification Drainage Operation.

- B. Water-Closet Supports:

1. Description: Combination carrier designed for accessible standard mounting height of wall-mounting, water-closet-type fixture. Include single or double, vertical or horizontal, hub-and-spigot or hubless waste fitting as required for piping arrangement; faceplates; couplings with gaskets; feet; and fixture bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space.

- C. Urinal Supports:

1. Description: Type I, urinal carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture II, urinal carrier with hanger and bearing plates for wall-mounting, urinal-type fixture. Include steel uprights with feet.
2. Accessible-Fixture Support: Include rectangular steel uprights.

- D. Lavatory Supports:

1. Description: Type I, lavatory carrier with exposed arms and tie rods II, lavatory carrier with concealed arms and tie rod III, lavatory carrier with hanger plate and tie rod for wall-mounting, lavatory-type fixture. Include steel uprights with feet.
2. Accessible-Fixture Support: Include rectangular steel uprights.

4.05 WATER CLOSETS

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

1. American Standard Companies, Inc.

2. Kohler Co.
3. TOTO

B. Description: Refer to fixture schedule on the Drawings..

4.06 URINALS

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

1. American Standard Companies, Inc.
2. TOTO
3. Kohler Co.

B. Description: Refer to fixture schedule on the Drawings.

4.07 LAVATORIES

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

1. American Standard Companies, Inc.
2. TOTO
3. Kohler Co.
4. Eljer.

B. Description: Refer to fixture schedule on the Drawings.

PART 3 EXECUTION

5.01 EXAMINATION

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

5.02 INSTALLATION

- A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.
- B. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.
- C. Use carrier supports with waste fitting and seal for back-outlet fixtures.
- D. Use carrier supports without waste fitting for fixtures with tubular waste piping.
- E. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.
- F. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.
- G. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.
- H. Install wall-mounting fixtures with tubular waste piping attached to supports.
- I. Install floor-mounting, back-outlet water closets attached to building floor substrate and wall bracket and onto waste fitting seals.
- J. Install counter-mounting fixtures in and attached to casework.
- K. Install fixtures level and plumb according to roughing-in drawings.
- L. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.

- M. Exception: Use ball, gate, or globe valves if supply stops are not specified with fixture. Valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
- N. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.
- O. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.
- P. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.
- Q. Install toilet seats on water closets.
- R. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
- S. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves.
- T. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
- U. Install traps on fixture outlets.
- V. Exception: Omit trap on fixtures with integral traps.
- W. Exception: Omit trap on indirect wastes, unless otherwise indicated.
- X. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Division 22 Section "Common Work Results for Plumbing."
- Y. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section "Joint Sealants."

5.03 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

5.04 FIELD QUALITY CONTROL

- A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.
- B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.
- C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.
- D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.
- E. Install fresh batteries in sensor-operated mechanisms.

5.05 ADJUSTING

- A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

- B. Operate and adjust disposers hot-water dispensers and controls. Replace damaged and malfunctioning units and controls.
- C. Adjust water pressure at faucets and flushometer valves to produce proper flow and stream.
- D. Replace washers and seals of leaking and dripping faucets and stops.
- E. Install fresh batteries in sensor-operated mechanisms.

5.06 CLEANING

- A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:
 - B. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
 - C. Remove sediment and debris from drains.
 - D. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

5.07 PROTECTION

- A. Provide protective covering for installed fixtures and fittings.
- B. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION

22 45 00

EMERGENCY PLUMBING FIXTURES

PART 1 GENERAL

3.01 RELATED DOCUMENTS

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

3.02 SUMMARY

- A. Section Includes:
 - 1. Emergency showers.
 - 2. Eyewash equipment.
 - 3. Eye/face wash equipment.
 - 4. Combination units.
 - 5. Supplemental equipment.
 - 6. Water-tempering equipment.

3.03 DEFINITIONS

- A. Accessible Fixture: Emergency plumbing fixture that can be approached, entered, and used by people with disabilities.
- B. Plumbed Emergency Plumbing Fixture: Fixture with fixed, potable-water supply.
- C. Self-Contained Emergency Plumbing Fixture: Fixture with flushing-fluid-solution supply.
- D. Tepid: Moderately warm.

3.04 REFERENCE STANDARDS

- A. ASME A112.18.2 - Plumbing Waste Fittings; 2020 (Reaffirmed 2025).
- B. ICC A117.1 - Accessible and Usable Buildings and Facilities; 2017.
- C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D. NSF 61 - Drinking Water System Components - Health Effects; 2025, with Addendum
- E. NSF 372 - Drinking Water System Components - Lead Content; 2024.

3.05 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include flow rates and capacities, furnished specialties, and accessories.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, and mounting details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
 - 4. Include diagrams for power, signal, and control wiring.

3.06 INFORMATIONAL SUBMITTALS

- A. Product Certificates: Submit certificates of performance testing specified in "Source Quality Control" Article.
- B. Field quality-control test reports.

3.07 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For emergency plumbing fixtures to include in operation and maintenance manuals.

3.08 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Flushing-Fluid Solution: Separate lot and equal to at least 200 percent of amount of solution installed for each self-contained unit.

PART 2 PRODUCTS

4.01 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ISEA Standard: Comply with ISEA Z358.1.
- C. NSF Standard: Comply with NSF 61 and NSF 372, for fixture materials that will be in contact with potable water.
- D. Regulatory Requirements: Comply with requirements in ICC A117.1, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.

4.02 EMERGENCY SHOWERS

- A. Freestanding, Plumbed Emergency Showers:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acorn Safety; a Division of Morris Group International.
 - b. Bradley Corporation.
 - c. Encon Safety Products.
 - d. Guardian Equipment Co.
 - e. Haws Corporation.
 - f. Speakman Company.
 - g. WaterSaver Faucet Co.
 - 2. Capacity: Not less than 20 gpm for at least 15 minutes.
 - 3. Supply Piping: NPS 1-1/4 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
 - 4. Control-Valve Actuator: Pull rod.
 - 5. Shower Head: 8-inch- minimum-diameter, stainless steel.
 - 6. Mounting: Pedestal.

4.03 EYEWASH EQUIPMENT

- A. Standard, Freestanding, Plumbed Eyewash Units:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acorn Safety; a Division of Morris Group International.
 - b. Bradley Corporation.
 - c. Encon Safety Products.
 - d. Guardian Equipment Co.
 - e. Haws Corporation.
 - f. Speakman Company.
 - g. Stingray Systems LLC.
 - h. WaterSaver Faucet Co.
 - 2. Capacity: Not less than 0.4 gpm for at least 15 minutes.

3. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
 4. Control-Valve Actuator: Paddle.
 5. Spray-Head Assembly: Two receptor-mounted spray heads.
 6. Receptor: Chrome-plated brass or stainless-steel bowl.
 7. Drain Piping:
 - a. Size: NPS 1-1/4 minimum.
 - b. Finish: Chrome-plated brass.
 - c. Fittings: Receptor drain, P-trap, waste to wall, and wall flange complying with ASME A112.18.2/CSA B125.2.
 8. Drain Piping: Include galvanized-steel indirect connection to drainage system.
 9. Mounting: Pedestal.
- B. Sink, Swivel-Type, Plumbed Eyewash Unit,:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acorn Safety; a Division of Morris Group International.
 - b. Bradley Corporation.
 - c. Encon Safety Products.
 - d. Guardian Equipment Co.
 - e. Haws Corporation.
 - f. Sellstrom Manufacturing Company.
 - g. Speakman Company.
 - h. WaterSaver Faucet Co.
 2. Capacity: Not less than 0.4 gpm for at least 15 minutes.
 3. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
 4. Control-Valve Actuator: Movement of spray-head assembly to position over sink.
 5. Spray-Head Assembly: Two spray heads with offset piping.
 6. Mounting: Deck next to sink.

4.04 COMBINATION UNITS

- A. Standard, Plumbed Emergency Shower with Eyewash Combination Units:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acorn Safety; a Division of Morris Group International.
 - b. Bradley Corporation.
 - c. Encon Safety Products.
 - d. Guardian Equipment Co.
 - e. Haws Corporation.
 - f. Speakman Company.
 - g. WaterSaver Faucet Co.
 2. Piping:
 - a. Material: Chrome-plated brass or stainless steel.
 - b. Unit Supply: NPS 1-1/2.
 - c. Unit Drain: Outlet at back or side near bottom.
 3. Shower:
 - a. Capacity: Not less than 20 gpm for at least 15 minutes.
 - b. Supply Piping: NPS 1 with flow regulator and stay-open control valve.
 - c. Control-Valve Actuator: Pull rod.
 - d. Shower Head: 8-inch- minimum diameter, stainless steel.
 - e. Mounting: Pedestal.

4. Eyewash Unit:
 - a. Capacity: Not less than 0.4 gpm for at least 15 minutes.
 - b. Supply Piping: NPS 1/2 with flow regulator and stay-open control valve.
 - c. Control-Valve Actuator: Paddle.
 - d. Spray-Head Assembly: Two receptor-mounted spray heads.
 - e. Receptor: Chrome-plated brass or stainless-steel bowl.
 - f. Mounting: Attached shower pedestal.
 - g. Drench-Hose Option: May be provided instead of eyewash unit.
 - 1) Capacity: Not less than 0.4 gpm for at least 15 minutes.
 - 2) Drench Hose: Hand-held spray head with squeeze-handle actuator and hose.
 - 3) Mounting: Bracket on shower pedestal.

4.05 WATER-TEMPERING EQUIPMENT

- A. Hot- and Cold-Water, Water-Tempering Equipment:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acorn Safety; a Division of Morris Group International.
 - b. Armstrong International, Inc.
 - c. Bradley Corporation.
 - d. Encon Safety Products.
 - e. Guardian Equipment Co.
 - f. Haws Corporation.
 - g. Leonard Valve Company.
 - h. POWERS; A WATTS Brand.
 - i. Speakman Company.
 - j. Stingray Systems LLC.
 - k. WATTS.
 2. Description: Factory-fabricated equipment with thermostatic mixing valve.
 - a. Thermostatic Mixing Valve: Designed to provide 85 deg F temperature tepid, potable water at emergency plumbing fixtures, to maintain temperature at plus or minus 5 deg F throughout required 15-minute test period, and in case of unit failure to continue cold-water flow, with union connections, controls, metal piping, and corrosion-resistant enclosure.
 - b. Supply Connections: For hot and cold water.

PART 3 EXECUTION

5.01 EXAMINATION

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

5.02 INSTALLATION OF EMERGENCY PLUMBING FIXTURE INSTALLATION

- A. Assemble emergency plumbing fixture piping, fittings, control valves, and other components.
- B. Install fixtures level and plumb.
- C. Fasten fixtures to substrate.
- D. Install shutoff valves in water-supply piping to fixtures, to facilitate maintenance of the equipment. Use ball or gate valve if specific type valve is not indicated. Install valves chained or locked in open position if permitted. Install valves in locations where they can easily be reached for operation. Comply with requirements for valves specified in Section 220523.12 "Ball Valves for Plumbing Piping" and Section 220523.15 "Gate Valves for Plumbing Piping."

1. Exception: Omit shutoff valve on supply to group of plumbing fixtures that includes emergency equipment.
 2. Exception: Omit shutoff valve on supply to emergency equipment if prohibited by authorities having jurisdiction.
- E. Install shutoff valve and strainer in steam piping and shutoff valve in condensate return piping. Comply with requirements for steam and condensate piping specified in Section 232213 "Steam and Condensate Heating Piping" and Section 232216 "Steam and Condensate Heating Piping Specialties."
- F. Install dielectric fitting in supply piping to emergency equipment if piping and equipment connections are made of different metals. Comply with requirements for dielectric fittings specified in Section 221116 "Domestic Water Piping."
- G. Install trap and waste piping on drain outlet of emergency equipment receptors that are indicated to be directly connected to drainage system. Comply with requirements for waste piping specified in Section 221316 "Sanitary Waste and Vent Piping."
- H. Install indirect waste piping on drain outlet of emergency equipment receptors that are indicated to be indirectly connected to drainage system. Comply with requirements for waste piping specified in Section 221316 "Sanitary Waste and Vent Piping."
- I. Install escutcheons on piping wall and ceiling penetrations in exposed, finished locations. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."
- J. Fill self-contained fixtures with flushing fluid.

5.03 CONNECTIONS

- A. Connect cold-water-supply piping to plumbed emergency plumbing fixtures not having water-tempering equipment. Comply with requirements for cold-water piping specified in Section 221116 "Domestic Water Piping."
- B. Connect hot- and cold-water-supply piping to hot- and cold-water, water-tempering equipment. Connect output from water-tempering equipment to emergency plumbing fixtures. Comply with requirements for hot- and cold-water piping specified in Section 221116 "Domestic Water Piping."
- C. Connect steam and cold-water-supply and condensate return piping to steam and cold water-tempering equipment. Connect output from water-tempering equipment to emergency plumbing fixtures. Comply with requirements for cold-water piping specified in Section 221116 "Domestic Water Piping" and comply with requirements for steam and condensate piping specified in Section 232213 "Steam and Condensate Heating Piping" and Section 232216 "Steam and Condensate Heating Piping Specialties."
- D. Connect cold water and electrical power to electric heating water-tempering equipment. Comply with requirements for cold-water piping specified in Section 221116 "Domestic Water Piping."
- E. Directly connect emergency plumbing fixture receptors with trapped drain outlet to sanitary waste and vent piping. Comply with requirements for waste piping specified in Section 221316 "Sanitary Waste and Vent Piping."
- F. Indirectly connect emergency plumbing fixture receptors without trapped drain outlet to sanitary waste or storm drainage piping.
- G. Where installing piping adjacent to emergency plumbing fixtures, allow space for service and maintenance of fixtures.

5.04 IDENTIFICATION

- A. Install equipment nameplates or equipment markers on emergency plumbing fixtures and equipment and equipment signs on water-tempering equipment. Comply with requirements for

identification materials specified in Section 220553 "Identification for Plumbing Piping and Equipment."

5.05 FIELD QUALITY CONTROL

- A. Mechanical-Component Testing: After plumbing connections have been made, test for compliance with requirements. Verify ability to achieve indicated capacities.
- B. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection.
 - 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Emergency plumbing fixtures and water-tempering equipment will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

5.06 ADJUSTING

- A. Adjust or replace fixture flow regulators for proper flow.
- B. Adjust equipment temperature settings.

END OF SECTION

22 47 13

DRINKING FOUNTAINS

PART 1 GENERAL

3.01 REFERENCE STANDARDS

- A. ASME A112.6.1M - Floor-Affixed Supports for Off-the-Floor Plumbing Fixtures for Public Use; 1997 (Reaffirmed 2017).
- B. ASME A112.18.2 - Plumbing Waste Fittings; 2020 (Reaffirmed 2025).
- C. ASME A112.19.3 - Stainless Steel Plumbing Fixtures; 2022.
- D. ICC A117.1 - Accessible and Usable Buildings and Facilities; 2017.
- E. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.
- F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- G. NSF 42 - Drinking Water Treatment Units – Aesthetic Effects; 2023.
- H. NSF 53 - Drinking Water Treatment Units – Health Effects; 2025.
- I. NSF 61 - Drinking Water System Components - Health Effects; 2025, with Addendum
- J. NSF 372 - Drinking Water System Components - Lead Content; 2024.

3.02 RELATED DOCUMENTS

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

3.03 SUMMARY

- A. Section Includes:
 - 1. Drinking fountains.
 - 2. Bottle filling stations.
 - 3. Supports.

3.04 ACTION SUBMITTALS

- A. Product Data: For each type of drinking fountain and bottle filling station.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
 - 2. Include operating characteristics, and furnished specialties and accessories.
- B. Sustainable Design Submittals:
- C. Shop Drawings:
 - 1. Include diagrams for power wiring.

3.05 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For drinking fountains and bottle filling stations to include in maintenance manuals.

3.06 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Filter Cartridges: Equal to 100 percent of quantity installed for each type and size indicated.

PART 2 PRODUCTS

4.01 PERFORMANCE REQUIREMENTS

A. Standards:

1. Drinking fountains and bottle filling stations intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), requirements of the Authority Having Jurisdiction (AHJ), and with NSF 61 or NSF 372, or be certified in compliance with NSF 61 or NSF 372 by an ANSI-accredited third-party certification body, that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.
2. Comply with ASME A112.19.3/CSA B45.4 for stainless steel drinking fountains and bottle filling stations.
3. Comply with NSF 42 and NSF 53 for water filters for drinking fountains and bottle filling stations.
4. Comply with ICC A117.1 for accessible drinking fountains and bottle filling stations.

4.02 DRINKING FOUNTAINS

A. Drinking Fountains - Surface Wall-Mounted, Stainless Steel.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Elkay.
 - b. Filtrine Manufacturing Company.
 - c. Halsey Taylor.
 - d. Haws Corporation.
 - e. Most Dependable Fountains, Inc.
 - f. Oasis International.
2. Source Limitations: Obtain surface wall-mounted, stainless steel drinking fountains from single source from single manufacturer.
3. Type: Vandal resistant.
4. Receptor(s):
 - a. Type: On horizontal support.
 - b. Shape: Rectangular.
 - c. Back Panel: [Stainless steel wall plate behind drinking fountain.
 - d. Bubblers: One for each receptor, with adjustable stream regulator, located on deck.
 - e. Drain: Grid type with NPS 1-1/4 tailpiece.
5. Maximum Water Flow: 0.5 gpm.
6. Control: Push bar.
7. Supply: NPS 3/8 with shutoff valve.
8. Waste Fitting: ASME A112.18.2/CSA B125.2, NPS 1-1/4 chrome-plated brass P-trap and waste.
9. Filter: One or more water filters with capacity sized for unit peak flow rate.
10. Electrical Characteristics:
 - a. Volts: 120 V ac.
 - b. Phase: Single.
 - c. Hertz: 60 Hz.
11. Support: Provide manufacturer's mounting plate and drinking fountain carrier.
12. Drinking Fountain Mounting Height: Accessible in accordance with ICC A117.1 High/low - standard/accessible in accordance with ICC A117.1.
13. Freeze-Resistant Supply Fittings: Through wall freeze-resistant shutoff and flow-control valve assembly.

B. Bottle Filling Station - Surface Wall-Mounted, Stainless Steel:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Elkay.
 - b. Halsey Taylor.
 - c. Most Dependable Fountains, Inc.
 - d. Murdock Manufacturing; A Division of Morris Group International.
2. Source Limitations: Obtain surface wall-mounted, stainless steel, bottle filling stations from single source from single manufacturer.
3. Type: Vandal resistant.
4. Cabinet: Stainless steel.
5. Bottle Filler: Push-button activation[, with 20-second automatic shutoff timer. Fill rate 0.5 to 1.5 gpm.
6. Drain: Grid type with NPS 1-1/4 tailpiece.
7. Supply: NPS 3/8 with shutoff valve.
8. Waste Fitting: ASME A112.18.2/CSA B125.2, NPS 1-1/4 (DN 32) brass P-trap.
9. Filter: One or more water filters complying with NSF 42 and NSF 53 and with capacity sized for peak flow rate.
10. Support: Provide manufacturer's mounting plate and drinking fountain carrier.
11. Bottle Filling Station Mounting Height: Accessible in accordance with ICC A117.1.
12. Electrical Characteristics:
 - a. Volts: 120 V ac.
 - b. Phase: Single.
 - c. Hertz: 60 Hz.

4.03 SUPPORTS

- A. Drinking Fountain Carrier:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company.
 - b. MIFAB, Inc.
 - c. Wade Drains.
 - d. WATTS.
 - e. Zurn Industries, LLC.
 2. Standard: ASME A112.6.1M.

PART 3 EXECUTION

5.01 EXAMINATION

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

5.02 INSTALLATION

- A. Install fixtures level and plumb according to roughing-in drawings. For fixtures indicated for children, install at height required by authorities having jurisdiction.
- B. Set pedestal drinking fountains and bottle filling stations on flat surface in accordance with manufacturer's written installation instructions.
- C. Install recessed, drinking fountains and bottle filling stations secured to wood blocking in wall construction.
- D. Install off-the-floor carrier supports, affixed to building substrate, for wall-mounted fixtures.

- E. Install water-supply piping with shutoff valve on supply to each fixture to be connected to domestic-water distribution piping. Use ball valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Section 220523.12 "Ball Valves for Plumbing Piping."
- F. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.
- G. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."
- H. Seal joints between fixtures and walls using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

5.03 PIPING CONNECTIONS

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

5.04 ELECTRICAL CONNECTIONS

- A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.
- C. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
 - 1. Nameplates to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
 - 2. Nameplates to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch (12.7 mm) high.

5.05 ADJUSTING

- A. Adjust fixture flow regulators for proper flow and stream height.

5.06 CLEANING

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

END OF SECTION

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Coordinate with Commissioning Requirements indicated in Section 019113. This contractor is responsible to comply with all requirements for the above section.

1.02 SUMMARY

- A. This Section includes the following:
- B. Related Sections:
 - 1. Section 013300 Submittals.

1.03 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

1.04 REFERENCE STANDARDS

- A. ASME B1.20.1 - Pipe Threads, General Purpose, Inch; 2013 (Reaffirmed 2018).
- B. ASME B18.2.1 - Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series); 2012 (Reaffirmed 2021).
- C. ASTM B32 - Standard Specification for Solder Metal; 2020.
- D. ASTM B813 - Standard Specification for Water Flushable Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube; 2024.
- E. ASTM B828 - Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings; 2023.
- F. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120; 2021a.
- G. ASTM D2657 - Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings; 2007 (Reapproved 2023).
- H. ASTM D3139 - Standard Specification for Joints for Plastic Pressure Pipes using Flexible Elastomeric Seals; 2019 (Reapproved 2025).

1.05 SUBMITTALS

- A. Product Data: For the following:
- B. Welding certificates.

1.06 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
- C. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.08 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for HVAC installations.
- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- C. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."
- D. Prepare Coordination / Installation Shop drawings to a scale of 1/4"=1'0" or larger; detailing major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:

PART 2 PRODUCTS

2.01 APPLICABLE CODES

- A. Obtain all required permits and inspections for all work required by the Contract Documents and pay all required fees in connection thereof.
- B. Arrange with the serving utility companies for the connection of all required utilities and pay all charges, meter charges, connection fees and inspection fees, if required.
- C. Comply with all applicable codes, specifications, local ordinances, industry standards, utility company regulations and the applicable requirements of the following nationally accepted codes and standards:
- D. Where differences existing between the Contract Documents and applicable state or city building codes, state and local ordinances, industry standards, utility company regulations and the applicable requirements of the above listed nationally accepted codes and standards, the more stringent or costly application shall govern. Promptly notify the Engineer in writing of all differences.
- E. When directed in writing by the Engineer, remove all work installed that does not comply with the Contract Documents and applicable state or city building codes, state and local ordinances, industry standards, utility company regulations and the applicable requirements of the above listed nationally accepted codes and standards, correct the deficiencies, and complete the work at no additional cost to the Owner.

- F. Contractor will comply will all current (date of permit) City of Pflugerville Building Codes and ordnances for construction.

2.02 DRAWINGS & SPECIFICATIONS

- A. These Specifications are intended to supplement the Drawings and it will not be the province of the Specifications to mention any part of the work which the Drawings are competent to fully explain in every particular and such omission is not to relieve the Contractor from carrying out portions indicated on the Drawings only.
- B. Should items be required by these Specifications and not indicated on the Drawings, they are to be supplied even if of such nature that they could have been indicated thereon. In case of disagreement between Drawings and Specifications, or within either Drawings or Specifications, the better quality or greater quantity of work shall be estimated and the matter referred to the Architect or Engineer for review with a request for information and clarification at least 7 working days prior to bid opening date for issuance of an addendum.
- C. The listing of product manufacturers, materials and methods in the various sections of the Specifications, and indicated on the Drawings, is intended to establish a standard of quality only. It is not the intention of the Owner or Engineer to discriminate against any product, material or method that is equal to the standards as indicated and/or specified, nor is it intended to preclude open, competitive bidding. The fact that a specific manufacturer is listed as an acceptable manufacturer should not be interpreted to mean that the manufacturers' standard product will meet the requirements of the project design, Drawings, Specifications and space constraints.
- D. The Architect or Engineer and Owner shall be the sole judge of quality and equivalence of equipment, materials and methods.
- E. Products by other reliable manufacturers, other materials, and other methods, will be accepted as outlined, provided they have equal capacity, construction, and performance. However, under no circumstances shall any substitution by made without the written permission of the Architect or Engineer and Owner. Request for prior approval must be made in writing 10 days prior to the bid date without fail.
- F. Wherever a definite product, material or method is specified and there is not a statement that another product, material or method will be acceptable, it is the intention of the Owner or Engineer that the specified product, material or method is the only one that shall be used without prior approval.
- G. Wherever a definite material or manufacturer's product is specified and the Specification states that products of similar design and equal construction from the specified list of manufacturers may be substituted, it is the intention of the Owner or Engineer that products of manufacturers that are specified are the only products that will be acceptable and that products of other manufacturers will not be considered for substitution without approval.
- H. Wherever a definite product, material or method is specified and there is a statement that "OR EQUAL" product, material or method will be acceptable, it is the intention of the Owner or Engineer that the specified product, material or method or an "OR EQUAL" product, material or method may be used if it complies with the specifications and is submitted for review to the Engineer as outline herein. Where permission to use substituted or alternative equipment on the project is granted by the Owner or Engineer in writing, it shall be the responsibility of the Contractor or Subcontractor involved to verify that the equipment will fit in the space available which includes allowances for all required Code and maintenance clearances, and to coordinate all equipment structural support, plumbing and electrical requirements and provisions with the Mechanical (HVAC) and Plumbing Design Documents and all other trades.
- I. Coordinate with Division 1 requirements for substitution, unless noted otherwise the Contractors wishing to substitute products, materials or methods from those indicated or specified, shall submit such requests to the Owner or Engineer in writing and within THIRTY

(30) WORKING DAYS OF NOTIFICATION OF CONTRACT AWARD. Requests for permission to utilize alternates or substitutions will not be considered after that time, unless the Specified item is unavailable or will adversely effect to completion of the Project. Claims submitted for consideration will require notarized letters from all parties involved and will be considered only if the Contractor has been timely in his delivery for review of all required equipment and material submittals. Owner or Engineer will investigate such requests for substitution and if acceptable will issue a letter allowing the substitution.

- J. If any request for a substitution of product, material or method is rejected, the Contractor will automatically be required to furnish the product, material or method named in the Specifications. Repetitive requests for substitutions will not be considered.
- K. Requests shall be bound and shall consist of three (3) sets of descriptive literature and performance data covering each item of equipment or material. The submittal shall include the following:
- L. The Owner or Engineer will investigate all requests for substitutions when submitted in accordance with above and if accepted, will issue a letter allowing the substitutions. The Engineer shall be the sole authority to approve or disapprove any and all substitutions.
- M. Where equipment other than that used in the design as specified or shown on the Drawings is substituted (either from an approved manufacturers list or by submittal review), it shall be the responsibility of the substituting Contractor to coordinate space requirements, building provisions and connection requirements with his trades and all other trades and pay all additional costs to other trades, the Owner, the Architect or Engineer, if any, due to the substitutions.

2.03 RECORD DOCUMENTS

- A. Prepare record documents in accordance with the requirements in Special Project Requirements, in addition to the requirements specified in Division 15, indicate the following installed conditions.
- B. The Contractor shall maintain a set of clearly marked black line record "AS-BUILT" prints on the job site on which he shall mark all work details, alterations to meet site conditions and changes made by "Change Order" notices. These shall be kept available for inspection by the Owner, Architect or Engineer at all times.
- C. Contractor Startup and Commissioning Verification - the system will provide a secure page for each integrated system allowing the contractor responsible for each phase to sign on and certify the status of each piece of equipment.
- D. Refer to Division 1 for additional requirements concerning record drawings. If the Contractor does not keep an accurate set of as-built drawings, the pay request may be altered or delayed at the request of the Architect. Mark the drawings with a colored pencil. Delivery of as built prints and re-producible is a condition of final acceptance.
- E. The record prints shall be updated on a daily basis and shall indicate accurate dimensions for all buried or concealed work, precise locations of all concealed pipe or duct, locations of all concealed valves, controls and devices and any deviations from the work shown on the Construction Documents which are required for coordination. All dimensions shall include at least two dimensions to permanent structure points.
- F. At the Engineer's option, the Contractor shall transfer all data from the record "AS-BUILT" prints to an electronic media such as AutoCAD latest release, in order to plot the reproducible media "AS-BUILT" drawings. Since data stored on electronic media can deteriorate undetected or be modified without the Engineer's knowledge, the AutoCAD electronic drawing files are provided without warranty or obligation on the part of the Engineer as to accuracy or information contained in the files. All information in the files shall be independently verified by the user. Any user shall agree to indemnify and hold the Engineer harmless from any and all claims,

damages, losses, and expenses including but not limited to Attorney's fees arising out of the use of the AutoCAD drawing files. Engineer shall furnish to the Contractor electronic media files of Contract Documents for the Contractor to use for inputting of the data from the record "AS-BUILT" prints and the Contractor shall return the revised electronic files on CD ROM properly labeled to the Engineer and shall submit the plotted reproducible drawings and three (3) sets of black line prints to the Architect or Engineer for review prior to scheduling the final inspection at the completion of the work. The reproducible record "AS-BUILT" drawings shall have the Engineers Name and Seal removed or blanked out and shall be clearly marked and signed on each sheet as described in paragraph G.

- G. Contractor shall transfer all marks from the submit a set of clear concise set of reproducible record "AS-BUILT" drawings and shall submit the reproducible drawings with corrections made by a competent draftsman and three (3) sets of black line prints to the Architect or Engineer for review prior to scheduling the final inspection at the completion of the work. The reproducible record "AS-BUILT" drawings shall have the Engineers Name and Seal removed or blanked out and shall be clearly marked and signed on each sheet.

2.04 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.05 JOINING MATERIALS

- A. Refer to individual Division 23 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
1. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 2. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- E. Solder Filler Metals: ASTM B32, lead-free alloys. Include water-flushable flux according to ASTM B813.
- F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
- G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- H. Solvent Cements for Joining Plastic Piping:
- I. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

2.06 TRANSITION FITTINGS

- A. Plastic-to-Metal Transition Fittings: PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
1. Eslon Thermoplastics.
- B. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
1. Thompson Plastics, Inc.
- C. Plastic-to-Metal Transition Unions: MSS SP-107, PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.

1. NIBCO INC.
2. NIBCO, Inc.; Chemtrol Div.

2.07 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.
 1. Capitol Manufacturing Co.
 2. Central Plastics Company.
 3. Eclipse, Inc.
 4. Epco Sales, Inc.
 5. Hart Industries, International, Inc.
 6. Watts Industries, Inc.; Water Products Div.
 7. Zurn Industries, Inc.; Wilkins Div.
- D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
 1. Capitol Manufacturing Co.
 2. Central Plastics Company.
 3. Epco Sales, Inc.
 4. Watts Industries, Inc.; Water Products Div.
- E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
 1. Advance Products & Systems, Inc.
 2. Calpico, Inc.
 3. Central Plastics Company.
 4. Pipeline Seal and Insulator, Inc.
- F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
 1. Calpico, Inc.
 2. Lochinvar Corp.
- G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.
 1. Perfection Corp.
 2. Precision Plumbing Products, Inc.
 3. Sioux Chief Manufacturing Co., Inc.
 4. Victaulic Co. of America.

2.08 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
 1. Advance Products & Systems, Inc.
 2. Calpico, Inc.
 3. Metraflex Co.
 4. Pipeline Seal and Insulator, Inc.

2.09 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
- E. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.
- F. PVC Pipe: ASTM D1785, Schedule 40.
- G. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

2.10 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Cast-Brass Type: With set screw.
- D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
- E. One-Piece, Stamped-Steel Type: With set screw and chrome-plated finish.
- F. Split-Plate, Stamped-Steel Type: With concealed set screw or spring clips, and chrome-plated finish.
- G. One-Piece, Floor-Plate Type: Cast-iron floor plate.
- H. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.11 GROUT & FOUNDATION

- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
- B. Foundations and pads shall be constructed of reinforced concrete and shall be sized and reinforced as noted or detailed on the Drawings. As a minimum, pads shall be 6" thick, by width and length as required by item it is under, reinforced with 6 x 6 W2.9 x W2.9 Welded Wire mesh.
- C. Support attachments, unless otherwise noted on shown, shall be securely attached to the items foundation, pad or building structure, per manufacturers recommendations and shall be approved by the Architect.

PART 3 EXECUTION

3.01 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

-
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
 - E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
 - F. Install piping to permit valve servicing.
 - G. Install piping at indicated slopes.
 - H. Install piping free of sags and bends.
 - I. Install fittings for changes in direction and branch connections.
 - J. Install piping to allow application of insulation.
 - K. Select system components with pressure rating equal to or greater than system operating pressure.
 - L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
 - 1. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - 2. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
 - 3. Insulated Piping: One-piece, stamped-steel type with spring clips.
 - 4. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - 5. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
 - 6. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece or split-casting, cast-brass type with polished chrome-plated finish.
 - 7. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and set screw.
 - 8. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - 9. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type with concealed or exposed-rivet hinge and set screw or spring clips.
 - 10. Bare Piping in Equipment Rooms: One-piece, cast-brass type.
 - 11. Bare Piping in Equipment Rooms: One-piece, stamped-steel type with set screw.
 - 12. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
 - M. Sleeves are not required for core-drilled holes.
 - N. Permanent sleeves are not required for holes formed by removable PE sleeves.
 - O. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.
 - P. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
 - 1. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50.8 mm) above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 - 2. Steel Pipe Sleeves: For pipes smaller than NPS 6.
 - 3. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
 - 4. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50.8 mm) above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.
 - a. Seal space outside of sleeve fittings with grout.

- Q. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- R. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- S. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.
- T. Verify final equipment locations for roughing-in.
- U. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.02 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
- J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D3139.
- K. Plastic Non-pressure Piping Gasketed Joints: Join according to ASTM D 3212.
- L. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D2657.
- M. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

3.03 PIPING CONNECTIONS

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

3.04 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

- C. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

3.05 PAINTING

- A. Painting of HVAC systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."
- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.06 CONCRETE BASES

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

3.07 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 05 Section "Metal Fabrications" for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor HVAC materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

3.08 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor HVAC materials and equipment.
- B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

3.09 GROUTING

- A. Mix and install grout for HVAC equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY

- A. Related Sections:
 - 1. Section 013300 Submittals.
 - 2. Section 01524 Construction Waste Management

1.02 GENERAL REQUIREMENTS

- A. The requirements of the General Conditions and Supplementary Conditions apply to all work herein.
- B. Coordinate with Commissioning Requirements indicated in Section 019113. This contractor is responsible to comply with all requirements for the above section.

1.03 SCOPE

- A. Scope of the Work shall include the furnishing and complete installation of the equipment covered by this Section, with all auxiliaries, ready for Owner's use.

1.04 WORK SPECIFIED ELSEWHERE

- A. Painting
- B. Automatic temperature controls.
- C. Power control wiring to motors and equipment.

1.05 REFERENCES

- A. AFBMA 9 – Load Ratings and Fatigue Life for Ball Bearings.
- B. AFBMA 11 – Load Ratings and Fatigue Life for Roller Bearings.
- C. ANSI/IEEE 112 – Test Procedure for Polyphase Induction Motors and Generators.
- D. ANSI/NEMA MG 1 – Motors and Generators.
- E. ANSI/NEMA MG 2 – Safety Standard for Construction and Guide for Selection, Installation and Use of Electric Motors.
- F. ANSI/NFPA 70 – National Electrical Code, 2017 Edition.
- G. ANSI/UL 674 – Electric Motors and Generators for Use in Hazardous (Classified) Locations.
- H. ANSI/UL 1004 – Electric Motors.
- I. EISA - The Energy Independence & Securities Act 2007.
- J. IECC – International Energy Conservation Code, 2015 edition with City of Yoakum, Texas amendments.
- K. IMC – International Mechanical Code, 2015 edition with City of Yoakum, Texas amendments.

1.06 WARRANTY

- A. Warrant the Work specified herein for one (1) year and motors for five (5) years beginning on data of Substantial Completion against becoming unserviceable or causing an objectionable appearance resulting from either defective or non-conforming materials or workmanship.

1.07 QUALITY ASSURANCE

- A. Motors associated with variable frequency drives (VFD) shall be inverter-duty rated, and provided with grounded shaft or ceramic bearings to insulate shaft, and Class F 221 degrees Fahrenheit (105 degrees Celsius) rise insulation. Ref. NEMA MG1 Part 31.

1.08 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Section 23 05 00.

- B. Shop Drawings: Provide wiring diagrams with electrical characteristics and connection requirements.
- C. Product Data: Submit schedules, charts, literature, and illustrations to indicate the performance, fabrication procedures variations, and accessories.
- D. Motor Nameplate Information: Manufacturer's name, address, utility and operating data. Bandwidth: submit bandwidth requirements for all Ethernet connections to the Local Network.
- E. Submit test results verifying nominal efficiency and power factor for motors 1 horsepower and larger.
- F. Submit manufacturer's installation instructions under provisions of Section 23 05 00. Indicate setting, mechanical connections, lubrication, and wiring instructions.
- G. Refer to Division 01 for additional requirements.

1.09 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data under provisions of Section 23 05 00.
- B. Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.10 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacture of electric motors for commercial use, and their accessories, with minimum three (3) years' documented product development, testing, and manufacturing experience.

1.11 REGULATORY REQUIREMENTS

- A. Conform to the National Electrical Code.

1.12 DELIVERY, STORAGE AND HANDLING

- A. Delivery: Deliver products to site under provisions of Section 23 05 00. Deliver clearly labeled, undamaged materials in the manufacturers' unopened containers.
- B. Time and Coordination: Deliver materials to allow for minimum storage time at the project site. Coordinate delivery with the scheduled time of installation.
- C. Storage:
 - 1. Store and protect products under provisions of Section 23 05 00.
 - 2. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof coverings. For extended outdoor storage, remove motors from equipment and store separately.

1.13 MAINTENANCE

- A. Provide twelve (12) months maintenance of all materials and equipment under this Section. Cost of the twelve (12) month normal and preventive maintenance shall be included within this scope of work.

PART 3 PRODUCTS

2.01 GENERAL

2.02 REFERENCE STANDARDS

- A. IEEE 112 - IEEE Standard Test Procedure for Polyphase Induction Motors and Generators; 2017.
- B. IEEE 519 - IEEE Standard for Harmonic Control in Electric Power Systems; 2022.
- C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

-
- D. UL 674 - Electrical Motors and Generators for Use in Hazardous (Classified) Locations; Current Edition, Including All Revisions.
 - E. UL 1004 - Standard for Electric Motors; Current Edition, Including All Revisions.
 - F. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.
 - G. Electrical Service: Refer to Drawing schedules for required electrical characteristics.
 - H. Approved Manufacturers: Provide motors by a single manufacturer as much as possible.
 - 1. Baldor-Reliance.
 - 2. General Electric ES Energy Saver®.
 - 3. Siemens.
 - 4. Marathon® manufactured by Regal-Beloit America, Inc.
 - 5. U.S. Electrical – NEMA Premium Efficiency.
 - I. Motor Characteristics
 - 1. Duty: Continuous duty at ambient temperature of 104 degrees Fahrenheit (40 degrees Celsius) and at altitude of 3300 feet (100584 cm) above sea level.
 - 2. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.
 - J. General: Comply with NEMA MG 1 unless otherwise indicated.
 - K. Temperature Rise: Match insulation rating.
 - L. Starting Capability: As required for service indicated five (5) starts minimum per hour.
 - M. Phases and Current: Verify electrical service compatibility with motors to be used.
 - 1. Up to 1/2 hp: Provide permanent split, capacitor-start single phase with inherent overload protection.
 - 2. 3/4 hp and larger: Provide NEMA MG 1, Design B, squirrel-cage induction polyphase.
 - 3. Provide two (2) separate windings on 2-speed polyphase motors.
 - 4. Name plate voltage shall be the same as the circuit's normal voltage, serving the motor.
 - N. Service Factor: 1.15 for polyphase; 1.35 for single phase.
 - O. Starting Code Letter Designation:
 - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
 - 2. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.
 - P. Frames: U-frames 1.5 hp and larger.
 - Q. Bearings: Provide sealed regreasable, shielded, anti-friction ball bearings; with top mounted Alemite lubrication fittings and bottom side drains minimum average life 100,000 hours typically, and others as follows:
 - 1. Design for radial and thrust loading where applicable.
 - 2. Permanently Sealed: Where not accessible for greasing.
 - 3. Sleeve-Type with Oil Cups: Light duty fractional horsepower motors or polyphase requiring minimum noise level.
 - R. Enclosure Type: Provide enclosures as follows:
 - 1. Concealed Indoor: Open drip proof (ODP).
 - 2. Exposed Indoor: Guarded.
 - 3. Outdoor Typical: Type II, TEFC.
 - 4. Outdoor Weather Protected: Type II, TEFC.

- S. Overload Protection: Built-in sensing device for stopping motor in all phase legs and signaling where indicated for fractional horse power motors.
- T. Noise Rating: "Quiet" except where otherwise indicated.
- U. Efficiency: Provide premium efficient motors as defined in NEMA MG 1 inch (25.4 mm) accordance with minimum full load efficiency listed in the following table, when tested in accordance with IEEE Test Procedure 112A, Method B, including stray load loss measure.
- V. Thermal Protection:
 - 1. Polyphase Motors: Comply with NEMA MG 1 requirements for thermally protected motors.
 - 2. Single Phase Motors: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.
- W. Additional Requirements for Polyphase Motors
 - 1. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
 - 2. Motors Used with Variable-Frequency Controllers:
 - a. Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
 - b. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width-modulated inverters.
 - c. Premium-Efficient Motors: Class B temperature rise; Class F insulation.
 - d. Inverter-Duty Motors: Class F temperature rise; Class H insulation.

2.03 MOTOR EFFICIENCIES – NOMINAL, FULL LOAD, THREE PHASE

OPEN DRIP-PROOF (ODP)			TOTALLY ENCLOSED FAN-COOLED (TEFC)			360 0 R P M
MOTOR HP	1200 RPM	1800 RPM	3600 RPM	1200 RPM	1800 RPM	
1	82.5	85.5	80.0	82.5	85.5	78.5
1.5	86.5	86.5	85.5	87.5	86.5	85.5
2	87.5	86.5	86.5	88.5	86.5	86.5
3	89.5	89.5	86.5	89.5	89.5	88.5
5	89.5	89.5	89.5	89.5	89.5	89.5
7.5	91.7	91.0	89.5	91.7	91.7	91.0
10	91.7	91.7	90.2	91.7	91.7	91.7
15	92.4	93.0	91.0	92.4	92.4	91.7

OPEN DRIP-PROOF (ODP)			TOTALLY ENCLOSED FAN-COOLED (TEFC)			3600 RPM
MOTOR HP	1200 RPM	1800 RPM	3600 RPM	1200 RPM	1800 RPM	
20	92.4	93.0	92.4	92.4	93.0	92.4
25	93.0	93.6	93.0	93.0	93.6	93.0
30	93.6	94.1	93.0	93.6	93.6	93.0
40	94.1	94.1	93.6	94.1	94.1	93.6
50	94.1	94.5	93.6	94.1	94.5	94.1
60	95.0	95.0	94.1	94.5	95.0	94.1
75	95.0	95.0	94.5	95.0	95.4	94.5
100	95.0	95.4	94.5	95.4	95.4	94.5
125	95.4	95.4	95.0	95.4	95.4	95.0
150	95.8	95.8	95.4	95.8	95.8	95.4
200	95.4	95.8	95.4	95.8	96.2	95.8

2.01 NEMA OPEN MOTOR SERVICE FACTORS

HP	3600 RPM	1800 RPM	1200 RPM	900 RPM
1/6	1.35	1.35	1.35	1.35
1/2	1.25	1.25	1.25	1.15
3/4	1.25	1.25	1.15	1.15
1	1.25	1.15	1.15	1.15
1.5 - 150	1.15	1.15	1.15	1.15

2.01 MOTOR CONTROLLERS (STARTERS)

- A. All motor controllers (for equipment furnished under Division 23) shall be furnished under Division 26 and installed under Division 26 unless otherwise noted on the plans.
- B. Motor starters shall be furnished as follows.
 1. General: Motor starters shall be Schneider-Electric Class 8536 across-the-line magnetic type, full-voltage, non-reversing (FVNR) starter. All starters shall be constructed and tested in accordance with the latest NEMA standards, sizes and horsepower. IEC sizes are not acceptable. Starters shall be mounted in a general purpose dead front, painted steel enclosure and surface-mounted. Provide size and number of poles as shown and required by equipment served. Provide a two speed, two winding or two speed, single winding motor starter as required for two speed motors.

2. Contacts: Magnetic starters' contacts shall be double break solid silver alloy.
 3. All contacts shall be replaceable without removing power wiring or removing starter from panel. The starter shall have straight-through wiring.
 4. Operating Coils: Operating coils shall be 120 volts and shall be of molded construction. When the coil fails, the starter shall open and shall not lock in the closed position.
 5. Overload Relays: Provide manual reset, trip-free Class 20 overload relays in each phase conductor in of all starters. Overload relays shall be melting alloy type with visual trip indication. All 3 phase and single phase starters shall have one overload relay in each underground conductor. Relay shall not be field adjustable from manual to automatic reset. Provide 6 overload relays for two speed motor starters.
 6. Pilot Lights: Provide a red running pilot light for all motor starters. Pilot lights shall be mounted in the starter enclosure cover. Pilot lights shall be operated from an interlock on the motor starter and shall not be wired across the operating coil.
 7. Controls: Provide starters with HAND-OFF-AUTOMATIC switches. Coordinate additional motor starter controls with the requirements of Division 23. Motor starter controls shall be mounted in the starter enclosure cover.
 8. Control Power Transformer: Provide a single-phase 480 volt control power transformer with each starter for 120 volt control power. Connect the primary side to the line side of the motor starter. The primary side shall be protected by a fuse for each conductor. The secondary side shall have one (1) leg fused and one (1) leg grounded. Arrange transformer terminals so that wiring to terminals will not be located above the transformer.
 9. Auxiliary Contacts: Each starter shall have one (1) normally open and one (1) normally closed convertible auxiliary contact in addition to the number of contacts required for the "holding interlock", remote monitoring, and control wiring. In addition, it shall be possible to field-install three more additional auxiliary contacts without removing existing wiring or removing the starter from its enclosure.
 10. Unit Wiring: Unit shall be completely pre-wired to terminals to eliminate any interior field wiring except for line and load power wiring and HVAC control wiring.
 11. Enclosures: All motor starter enclosures shall be NEMA 1, general purpose enclosures or NEMA 3R if mounted exposed to high moisture conditions. Provide NEMA 4X when located near cooling towers.
 12. Power Monitor: Provide a Macromatic PMPU phase failure and under-voltage relay, base and wiring required for starters serving motors 10 horsepower and larger. Set the under-voltage setting according to minimum voltage required for the motor to operate within its range.
- C. Approved Manufacturers: Controller numbers are based on first named manufacturer. Provide one of the following manufacturer's.
1. ABB
 2. Danfoss
 3. Yaskawa

2.02 COMBINATION MOTOR STARTERS

- A. General: Combination motor starters shall consist of a magnetic starter and a fusible or non-fusible disconnect switch in a dead front, painted steel NEMA 1 enclosure unless otherwise noted and shall be surface-mounted. Size and number of poles shall as shown and required by equipment served. Combination motor starters shall be as specified for motor starters in Paragraph 2.4.B, except as modified herein.
 - B. Disconnect Switch: Disconnect switches shall be as specified in Division 26.
 - C. Approved Manufacturers: Controller numbers are based on first named manufacturer. Provide one of the following manufacturer's.
1. Siemens.
 2. Schneider Electric.

3. ABB.

2.03 VARIABLE FREQUENCY DRIVES

A. Manufacturers

1. General:

- a. All products provided under this section shall either be Pre-certified or certified prior to bid as described below. If for any reason the product listed is not appropriate to fully meet the project requirements, alternate products shall be certified and bid as described below.
- b. Acceptable Manufacturers
 - 1) ABB
 - 2) Danfoss
 - 3) Yaskawa
2. Additional Product Certification: In the event that additional or alternate products from the listed Manufacturer of the Pre-Certified product line listed above are needed to accomplish the requirements of this project, additional products and applications shall be certified following the procedures and requirements of the certification specifications.
 - a. Any product that is not certified will not be accepted.
 - b. Upon satisfactory completion of the certification, a registration number will be issued for each product.
 - c. Include the registration number for each product in the submittal
 - d. The Owner reserves the right to accept or reject any products at their sole discretion as deemed in their best interest.

B. Where shown on the Drawings, adjustable frequency drives shall have the following features:

1. The VFD shall be rated for 480 VAC (optional input voltages of 208-240 VAC). The VFD shall provide microprocessor-based control for three-phase induction motors. The controller's full load output current rating shall be based on 40°C ambient and 5 kHz switching frequency continuous and utilize dynamic noise control for motors.
2. The VFDs shall be of the Pulse Width Modulated (PWM) design converting the utility input voltage and frequency to a variable voltage and frequency output via a two-step operation. Adjustable Current Source VFDs are not acceptable. Insulated Gate Bipolar Transistors (IGBTs) shall be used in the inverter section. Bipolar Junction Transistors, GTOs or SCRs are not acceptable. The VFDs shall run at the above listed switching frequencies.
3. The VFD's shall have efficiency at full load and speed that exceeds 95% for VFDs below 15 Hp and 97% for drives 15 Hp and above. The efficiency shall exceed 90% at 50% speed and load.
4. The VFDs shall maintain the line side displacement power factor at no less than 0.96, regardless of speed and load.
5. The VFDs shall have a one (1) minute overload current rating of 150% and a two (2) second overload current rating of 250% for constant torque drives. The VFDs shall have a one (1) minute overload current rating of 110% for variable torque drives.
6. The VFDs shall be capable of operating of operating any NEMA design B squirrel cage induction motor, regardless of manufacturer, with a horsepower and current rating within the capacity of the VFD.
7. The VFD's shall have an integral EMI/RFI filter as standard.
8. The VFD's shall limit harmonic distortion reflected onto the utility system to a voltage and current level as defined by IEEE 519-2014 for general systems applications, by utilizing the standard 5% nominal impedance integral AC three-phase line reactor.
9. Any harmonic calculations shall be done based on the kVA capacity, X/R ratio and the impedance of the utility transformer feeding the installation, as noted on the drawings, and the total system load. The calculations shall be made with the point of common coupling being the point where the utility feeds multiple customers.

-
10. Total harmonic distortion shall be calculated under worst-case conditions in accordance with the procedure outlined in IEEE standard 519-2014. Copies of these calculations are to be made available upon request. The contractor shall provide any needed information to the VFD supplier three (3) weeks prior to requiring harmonic calculations.
 11. The system containing the VFDs shall comply with the 5% level of total harmonic distortion of line voltage and the line current limits as defined in IEEE 519-2014. If the system cannot meet the harmonic levels with the with the VFDs provided with the standard input line reactor or optional input isolation transformer, the VFD manufacturer shall supply either a 12-Pulse or an 18-pulse, multiple bridge rectifier ac to dc conversion section with phase shifting transformer or Matrix topology solution for all drives 50 Hp and above. This 18-pulse rectifier converter shall result in a multiple pulse current waveform that will more nearly approximate a true sine-wave to reduce voltage harmonic content on the utility line. The phase shifting transformer shall be of a single winding type to optimize its KVA rating and harmonic cancellation capability. Harmonic filters are not acceptable for drives 50 Hp and above.
 12. The VFD's shall be able to start into a spinning motor. The VFDs shall be able to determine the motor speed in any direction and resume operation without tripping. If the motor is spinning in the reverse direction, the VFDs shall start into the motor in the reverse direction, bring the motor to a controlled stop, and then accelerate the motor to the preset speed.
 13. Standard operating conditions shall be:
 - a. Incoming Power: Three-phase, 208 - 240 / 380 - 500 / 525 - 690 Vac (+10% to -15%) and 50/60 Hz (+/-5 Hz) power to a fixed potential DC bus level.
 - b. Frequency stability of +/-0.05% for 24 hours with voltage regulation of +/-1% of maximum rated output voltage.
 - c. Speed regulation of +/- 0.5% of base speed.
 - d. Load inertia dependent carryover (ride-through) during utility loss.
 - e. Insensitive to input line rotation.
 - f. Power loss ride through shall be adjustable through 2 seconds.
 - g. Humidity: 0 to 95% (non-condensing and non-corrosive).
 - h. Altitude: 0 to 3,300 feet (100584 cm) above sea level.
 - i. Ambient Temperature: -10 to 50°C (CT), -10 to 40°C (VT).
 - j. Storage Temperature: -40 to 60°C.
 14. Control Functions
 - a. VFD programmable parameters shall be adjustable from a digital operator keypad located on the front of the VFD. The VFDs shall have a 5 line alphanumeric programmable display with status indicators. Keypads must use plain English words for parameters, status, and diagnostic messages. Keypads that are difficult to read or understand are not acceptable, and particularly those that use alphanumeric code and tables. Keypads shall be adjustable for contrast with large characters easily visible in normal ambient light.
 - b. The keypad shall include a Local/Remote pushbutton selection. Both start/ stop source and speed reference shall be independently programmable for Keypad, Remote I/O, or Field Bus.
 - c. The keypad shall have copy / paste capability.
 - d. Upon initial power up of the VFD, the keypad shall display a startup guide that will sequence all the necessary parameter adjustments for general start up.
 - e. Standard advanced programming and trouble-shooting functions shall be available by using a personal computer's RS-232 port and Windows™ based software. In addition, the software shall permit control and monitoring via the VFD's RS232 port. The manufacturer shall supply free website download for the required software. An easily understood instruction manual and software help screens shall also be

- provided. The computer software shall be used for modifying the drive setup and reviewing diagnostic and trend information as outlined in this Section.
- f. The operator shall be able to scroll through the keypad menu to choose between the following:
 - 1) Monitor
 - 2) Operate
 - 3) Parameter setup
 - 4) Display parameter values
 - 5) Display current faults
 - 6) Fault history
 - 7) Keypad LCD contrast adjustment
 - 8) Information to indicate the standard software and optional features software loaded.
 - g. The following setups and adjustments, at a minimum, are to be available:
 - 1) Start command from keypad, remote or communications port
 - 2) Speed command from keypad, remote or communications port
 - 3) Motor direction selection
 - 4) Maximum and minimum speed limits
 - 5) Acceleration and deceleration times, two settable ranges
 - 6) Critical (skip) frequency avoidance
 - 7) Torque limit
 - 8) Multiple attempt restart function
 - 9) Multiple preset speeds adjustment
 - 10) Parameter for speed search to catch a spinning motor start or normal start selection
 - 11) Programmable analog output
 - 12) DC brake current magnitude and time
 - 13) PI process controller
15. The VFDs shall have the following system interfaces:
- a. Inputs – A minimum of six (6) programmable digital inputs, two (2) analog inputs and shall be provided with the following available as a minimum:
 - 1) Remote manual/auto
 - 2) Remote start/stop
 - 3) Remote forward/reverse
 - 4) Remote preset speeds
 - 5) Remote external trip
 - 6) Remote fault reset
 - 7) Process control speed reference interface, 4-20 mA dc
 - 8) Potentiometer and 1-10 Vdc speed reference interface
 - 9) RS232 programming and operation interface port
 - b. Provide a communications interface with all points and functions listed in this section connected to the BMS provided. A minimum of two (2) discrete programmable digital outputs, one (1) programmable open collector output, and one (1) programmable analog output shall be provided, with the following available at minimum.
 - 1) Programmable relay outputs with one (1) set of Form C contacts for each, selectable with the following available at minimum:
 - (a) Fault
 - (b) Run
 - (c) Ready
 - (d) Reversed
 - (e) Jogging

- (f) At speed
 - (g) Torque Limit Supervision
 - (h) Motor rotation direction opposite of commanded
 - (i) Over temperature
 - 2) Programmable open collector output with available 24Vdc power supply and selectable with the following available at minimum:
 - (a) Fault
 - (b) Run
 - (c) Ready
 - (d) Reversed
 - (e) Jogging
 - (f) At speed
 - (g) Torque Limit Supervision
 - (h) Motor rotation direction opposite of commanded
 - (i) Over temperature
 - 3) Programmable analog output signal, selectable with the following available at minimum:
 - (a) Motor current
 - (b) Output frequency
 - (c) Frequency reference
 - (d) Motor speed
 - (e) Motor torque
 - (f) Motor power
 - (g) Motor voltage
 - (h) DC-bus voltage
- 16. Monitoring and Displays
 - a. The VFD's display shall be a LCD type capable of displaying three (3) lines of text and the following thirteen (13) status indicators:
 - 1) Run
 - 2) Forward
 - 3) Reverse
 - 4) Stop
 - 5) Ready
 - 6) Alarm
 - 7) Fault
 - 8) I/O terminal
 - 9) Keypad
 - 10) Bus/Comm
 - 11) Local / Remote (LED)
 - 12) Fault)
 - b. The VFD's keypad shall be capable of displaying the following monitoring functions at a minimum:
 - 1) Output frequency
 - 2) Frequency reference
 - 3) Motor speed
 - 4) Motor current
 - 5) Motor torque
 - 6) Motor power
 - 7) Motor voltage
 - 8) DC-bus voltage

- 9) Unit temperature
- 10) Voltage level of analog input
- 11) Current level of analog input
- 12) Digital inputs status
- 13) Digital and relay outputs status
- 14) Analog out
- 17. Protective Functions
 - a. The VFD shall include the following protective features at minimum:
 - 1) Over current
 - 2) Overvoltage
 - 3) Inverter fault
 - 4) Under voltage
 - 5) Input phase loss
 - 6) Output phase loss
 - 7) Under temperature
 - 8) Over temperature
 - 9) Motor stalled
 - 10) Motor under load
 - 11) Logic voltage failure
 - 12) Microprocessor failure
 - b. The VFD shall provide ground fault protection during power-up, starting, and running. VFD's with no ground fault protection during running are not acceptable.
- 18. Diagnostic Features
 - a. Ten (10) faults History
 - b. Record and log faults
- 19. Indicate the most recent first, and store up to ten (10) faults.
- 20. Additional features that must be included in the VFD:
 - a. Thermal or magnetic only circuit breaker to provide a disconnect means. Operating handle shall protrude the door. The disconnect shall not be mounted on the door. The handle position shall indicate ON, OFF, and TRIPPED condition. The handle shall have provisions for padlocking in the OFF position with at least three (3) padlocks. Interlocks shall prevent unauthorized opening or closing of the VFD door with the disconnect handle in the ON position. This shall be defeat able by maintenance personnel.
 - b. Three (3) contactor bypass shall include a drive input disconnect, an VFD input isolation contactor, bypass contactor and an VFD output contactor that is electrically and mechanically interlocked with the bypass contactor. This circuit shall include control logic, status lights and motor over current relays. The complete bypass system (Inverter-Off-Bypass) (Hand-Off-Auto with Inverter-Bypass) selector switch(s), and inverter/bypass pilot lights shall be packaged with the VFD. The unit may be set up for (Manual or Automatic) bypass operation upon an VFD trip.
 - c. Fused space heaters with thermostat for oversize enclosures to minimize condensation potential upon drive shutdown.
 - d. Motor over-current relay to provide motor over current sensing of a given level of load current.
 - e. Motor filter for use on motor cable runs exceeding 100 feet (3048 cm) for motors with a peak voltage insulation rating less than 1600 Vac. Motors without NEMA MG1, Part 31 construction shall be identified to bidders.
 - 1) The dV/dt filter shall be located at the VFD and shall reduce the dV/dt clamp any voltage overshoots of the VFD output. It will return the energy in the voltage

overshoots to the VFD's dc bus. A power dissipative resistance device is not acceptable. Filter shall be a Eaton MotoRx™ series.

21. The VFD manufacturer shall maintain, as part of a national network, engineering service facilities within 250 miles (402.34 kilometers) of project to provide start-up service, emergency service calls, repair work, service contracts, maintenance and training of customer personnel.

PART 4 EXECUTION

3.01 FACTORY TESTING

- A. The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of UL and NEMA standards.
 1. All printed circuit boards shall be functionally tested via automatic test equipment prior to unit installation.
 2. After all tests have been performed, each VFD shall undergo a burn-in test. The drive shall be burned in at 100% inductive or motor load without an unscheduled shutdown.
 3. After the burn-in cycle is complete, each VFD shall be put through a motor load test before inspection and shipping.
- B. The manufacturer shall provide three (3) certified copies of factory test reports.

3.02 FIELD QUALITY CONTROL

- A. Provide the services of a qualified manufacturer's employed Field Service Engineer to assist the Contractor in installation and start-up of the equipment specified under this section. Field Service personnel shall be factory trained with periodic updates and have experience with the same model of VFD's on the job site. Sales representatives will not be acceptable to perform this work. The manufacturer's service representative shall provide technical direction and assistance to the Contractor in general assembly of the equipment, installation as specified in manufacturer's installation instructions, wiring, application dependent adjustments, communications setup and verification of proper VFD operation.
- B. The following minimum work shall be performed by the Contractor under the technical direction of the manufacturer's service representative.
 1. Inspection and final adjustments.
 2. Operational and functional checks of VFDs and spare parts.
 3. Provide cable and connector to the IP drop supplied by Controls Contractor.
 4. Verify that the unit is properly configured for remote communication to the system.
 5. The Contractor shall certify that he has read the drive manufacturer's installation instructions and has installed the VFD in accordance with those instructions.
- C. The Contractor shall provide three (3) copies of the manufacturer's field start-up report before final payment is made.

3.03 MAINTNANCE / WARRANTY SERVICE

- A. Warranty to commence twelve (12) months from the date of start-up, not to exceed 36 months from the date of shipment, and include all parts, labor, and travel time.

3.04 FIELD TESTING

- A. The VFD manufacturer shall perform harmonic measurements at the point where the utility feeds multiple customers (PCC) to verify compliance with IEEE 519-2014. A report of the voltage THD and current TDD shall be sent to the engineer. The Contractor shall provide labor, material, and protection as needed to access the test points. The readings shall be taken with all drives and all other loads at full load, or as close as field conditions allow.

3.05 TRAINING

- A. The Contractor shall provide a training session for up to two (2) Owner's representatives for one (1) workday with a maximum of two (2) trips at a job site location determined by the Owner. Training and instruction time shall be in addition to that required for start-up service.
- B. The training shall be conducted by the manufacturer's qualified representative.
- C. The training program shall consist of the following:
 - 1. Instructions on the proper operation of the equipment.
 - 2. Instructions on the proper maintenance of the equipment.

END OF SECTION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Furnish and install supports, anchors and sleeves applicable to mechanical, plumbing, and fire protection systems, including:
 - 1. Pipe, duct, and equipment hangers, supports, and associated anchors.
 - 2. Equipment bases and supports.
 - 3. Sleeves and seals.
 - 4. Flashing and sealing equipment and pipe stacks.

1.02 REFERENCE STANDARDS

- A. NFPA 13 - Standard for the Installation of Sprinkler Systems; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.03 WORK FURNISHED BUT INSTALLED UNDER OTHER SECTIONS

- A. Provide hanger and support inserts and sleeves and coordinate placement into formwork.

1.04 RELATED SECTIONS

- A. Section 230700 – HVAC Insulation.
- B. Section 230716 – HVAC Equipment Insulation.
- C. Section 013300 Submittals.
- D. Section 01524 Construction Waste Management
- E. Section 01352 LEED Requirements
- F. Section 01611 Environmental Management
- G. Section 01570 Pollution Prevention and Control

1.05 SUBMITTALS

- A. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:
 - 1. Submit the following according to Conditions of the Construction Contract.
 - a. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Grinnell
- B. Kindrof
- C. Unistrut
- D. Specified Technologies, Inc.
- E. B-line
- F. Power Strut

2.02 PIPE HANGERS AND SUPPORTS

- A. Hangers for Non-Insulated Pipe Sizes 1/2 to 4-Inch: Provide malleable iron, adjustable swivel, split ring.
- B. Hangers for Insulated Pipe Sizes 1/2 to 3 Inches and Non-Insulated Pipe Sizes 6 Inches and Over: Galvanized carbon steel, adjustable, clevis.
- C. Supports for Single Hot Pipe Sizes 4 Inches and Over and Cold Pipe Sizes 4 Inches and Over; Carbon Steel Roller.

- D. Multiple or Trapeze Hangers: Galvanized steel channels with welded spacers and hangers rods, cast iron roll and stand for sizes 4 inches (101.6 mm) and larger hot water piping and 4 inches and larger chilled water piping.
- E. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
- F. Wall Support for Pipe Sizes to 4 Inches and Over: Welded steel bracket and wrought steel clamp; adjustable steel yoke and cast iron roll.
- G. Vertical Support: Steel riser clamp.
- H. Floor Support for Pipe Sizes 4 Inches and All Cold Pipe Sizes: Cast iron adjustable pipe saddle, locknut nipple, floor flange, and concrete pier or steel support.
- I. Floor Support for Pipe Sizes 6 Inches and Over: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
- J. Design hangers without disengagement of supported pipe.
- K. Copper Pipe Support and Hangers: Carbon steel ring, adjustable, copper plated.
- L. Shield for Insulated Piping 2 Inches and Smaller: 18 gauge galvanized steel shield over insulation in 180-degree segments, minimum 12 inches long at pipe support.
- M. Shield for Insulated Piping 2-1/2 Inch and Larger (Except Cold Water Piping): Use pipe support inserts.

PIPE	METAL GAUGE	SHIELD LENGTH
2 1/2" TO 5"	15	12"
6" TO 12"	14	24"
OVER 12"	12	24"

2.01 HANGER RODS

- A. Steel, threaded on both ends or one on one end or continuous threaded. Galvanized or cadmium plated.

2.02 INSERTS

- A. Provide 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.

2.03 FLASHING

- A. Metal Flashing: 26 gauge galvanized steel.
- B. Flexible Flashing: 47 mil (1.1938 mm) thick sheet butyl: compatible with roofing.
- C. Caps: Steel, 22 gauge minimum; use 16 gauge at fire resistant elements.

2.04 EQUIPMENT BASE AND SUPPORTS

- A. Provide 6" concrete pads and equipment bases for all outdoor equipment on grade, floor mounted equipment in main central plant area, areas with floor below grade, penthouse equipment rooms, floor mounted air handling units and where shown on Drawings.
- B. Provide prefabricated curbs or roof mounted equipment with the equipment. Equipment curb must compensate for slopped roof deck as required to set equipment level.

2.05 SLEEVES

- A. Sleeves for Pipes through Non-fire Rated Floors: Form with 16 gauge galvanized steel.
- B. Sleeves for Pipes through Non-fire Rated Beams, Walls, Above Grade: Form with 18 gauge galvanized steel.

- C. Sleeves for Pipes through Fire Rated and Fire Resistive Floors and Walls, and Fireproofing: Provide prefabricated fire rated sleeves including seals, UL listed; or provide Schedule 40 galvanized steel, sized for minimum 1 inch (25.4 mm) space between sleeve and carrier pipe.
- D. Sleeves for Pipe through Floor Supporting Riser Piping: Standard weight galvanized steel pipe.
- E. Sleeves for Pipes through Roof: Standard weight galvanized steel pipe.
- F. Sleeves for Round Ductwork: Form with galvanized steel.
- G. Sleeves for Rectangular Ductwork: Form with galvanized steel.
- H. Provide fire-stop compound at all penetrations of floor slabs or firewalls such that fire rating integrity of barrier is not lessened.
- I. Caulk: Caulk all sleeves water and airtight.
- J. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping. Provide pipe sleeves one size larger than the pipe it serves, including insulation, except where "Link Seal" casing seals are used.
- K. Sleeves Penetration Walls Below Grade: Provide "Link-Seal" and sleeve as manufactured by Thunderline Corporation, Wayne, Michigan, for all pipes passing through walls below grade.

2.06 FINISHES

- A. Prime coat and paint exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
- B. Provide galvanized hangers and supports for all piping and ductwork located in crawlspace, pipe shafts, and above suspended ceiling spaces.
- C. Provide hanger rods, bolts, nuts, and all metal parts coated with the same material as hangers.

2.07 ANCHOR BOLTS

- A. Provide galvanized anchor bolts for all equipment placed on concrete pads or on concrete slabs of the size and number recommended by the manufacturer of the equipment.

PART 3 EXECUTION

3.01 PIPE HANGERS AND SUPPORTS

- A. Support horizontal pipes as follows:

Pipe Size	Max. Hanger Spacing*	Hanger Diameter
1/2 to 1-1/4 inch (32 mm)	6'-0"	3/8"
1-1/2 to 2 inch (50.8 mm)	8'-0"	3/8"
2-1/2 to 3 inch (76.2 mm)	10'-0"	1/2"
4 to 6 inch (152.4 mm)	10'-0"	5/8"
8 to 12 inch	10'-0"	7/8"
14 inch (355.6 mm) and Over	14'-0"	1"
C.I. Bell and Spigot (or No-Hug)	5'-0" and at Joints	

*Comply with NFPA 13 for fire protection pipe hanger spacing.

** For PVC and Cast Iron pipes maximum hanger spacing shall not exceed 4 feet (121.92 cm) with 3/8" hanger rod and 5 feet (152.4 cm) with 5/8" hanger rod respectively.

- B. Install hangers to provide minimum 1/2-inch space between finished covering and adjacent work.

- C. Place a hanger within 12 inches (304.8 mm) of each horizontal elbow.
- D. Use hangers with 1-1/2 inch (38 mm) minimum vertical adjustment.
- E. Support horizontal cast iron pipe adjacent to each hub, with five feet maximum spacing between fingers.
- F. Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub.
- G. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
- H. Support riser piping independently of connected horizontal piping.
- I. Provide corrosion resistant hangers by Corr-Tech for all piping hangers in corrosive areas. Provide hanger rods, bolts, nuts and all metal parts coated with the same material as hangers.

3.02 LOW PRESSURE DUCT SUPPORT SCHEDULE

- A. All horizontal ducts up to and including 40 inches (1016 mm) in their greater dimension shall be supported by means of No. 18 U.S. gauge band iron hangers attached to the ducts by means of screws, rivets, or clamps and fastened to above inserts with toggle bolts, beam clamps or other approved means. Duct shall have at least one pair of supports 8' 0" on centers. Clamps shall be used to fasten hangers to reinforcing on sealed ducts.
- B. Horizontal ducts larger than 40 inches (1016 mm) in their greatest dimension shall be supported by means of hanger rods bolted to angle iron trapeze hangers. Duct shall have at least one pair of supports 8' 0" on centers according to the following:

ANGLE

LENGTH ANGLE ROD DIAMETER

- 1. 4' 0" 1-1/2" x 1-1/2" x 1/8" 1/4"
- 2. 6' 0" 1-1/2" x 1-1/2" x 1/8" 1/4"
- 3. 8' 0" 2" x 2" x 1/8" 5/16"
- 4. 10' 0" 3" x 3" x 1/8" 3/8"

- B. Vertical ducts shall be supported where they pass through the floor lines with 1-1/2" x 1-1/2" x 1/4" angles for ducts up to 60." Above 60", the angles must be increased in strength and sized on an individual basis considering space requirements.

5.02 MEDIUM PRESSURE DUCT SUPPORT SCHEDULE

- A. All horizontal rectangular ducts shall have duct hanger requirements as follows:

MINIMUM HANGER SIZE

MAX. DUCT STEEL GALV. STEEL MAX. MIN.#

DIMEN. ROD STRAP WIDTH SPACING HNGRS TRAPEZE SIZE

0 THROUGH 18" -- 1" X 16 GA. 10' 2 --

19" THROUGH 36" -- 1" X 16 GA. 10' 2 --

37" THROUGH 60" 3/8" 1" X 16 GA. 8' 2 2" X 2" X 1/4"

61" THROUGH 120" 3/8" 1-1/2" X 12 GA. 8' 2 2" X 2" X 1/4"

121" THROUGH 240" 3/8" -- 4' 3 2-1/2" X 2-1/2"

X 3/16"

- A. All horizontal round ducts shall have ducts hangers spaced 10' 0" maximum with requirements as follows:

DUCT DIAMETER MIN. HANGER SIZE NO. HANGERS HANGER RING SIZE

UP THROUGH 18" 1" X 16 GAUGE 1 1" X 16 GA.

19" TO 36" 1" X 12 GAUGE 1 1" X 12 GA.

37" TO 50" 1-1/2" X 12 GAUGE 1 1-1/2" X 12 GA.

51" TO 84" 1-1/2" X 12 GAUGE 2 SUPPORT BRACING ANGLE

19.01 INSERTS

- A. Provide inserts for placement in concrete formwork.
- B. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
- C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches (101.6 mm).
- D. Where concrete slabs form finished ceiling, provide inserts flush with slab surface.
- E. Where inserts are omitted, drill through concrete slab from below and provide thru-bolt with recessed square steel plate and nut recessed into and grouted flush with slab.

19.02 FLASHING

- A. Provide flexible flashing and metal counter-flashing where sleeves, piping and ductwork penetrate weather or waterproofed walls, floors, and roofs.
- B. Flexible sheet flash and counter-flash all curbs for mechanical equipment on roof with sheet metal; seal watertight.

19.03 EQUIPMENT BASES AND SUPPORTS

- A. Coordinate installation of equipment bases of concrete type specified for all outdoor equipment on grade and floor mounted equipment in main central plant area, areas with floors below grade, penthouse equipment rooms floor mounted air handling units and where shown on drawings.
- B. Provide templates, anchor bolts, and accessories for mounting and anchoring equipment
- C. Construct support of steel members. Brace and fasten with flanges bolted to structure.
- D. Provide rigid anchors for pipes after vibration isolation components are installed.
- E. Provide base of a minimum height of 4 inches (101.6 mm) above finished grade and a width that projects a minimum of 3 inches (76.2 mm) beyond equipment on all sides. Bevel edges of base.
- F. Prepare surface under bases by cleaning, clearing, chipping and roughing.
- G. Provide curbs of 14 inches (355.6 mm) minimum height above roofing surface for installation of mechanical equipment on roof.

19.04 CONCRETE FOUNDATIONS ("HOUSEKEEPING PADS")

- A. Concrete foundations for the support of equipment such as floor mounted panels, pumps, fans, air handling units, etc., shall extend 4" on all sides beyond the limits of the mounted equipment unless otherwise noted and shall be poured in forms built of new dressed 6" nominal lumber. All corners of the foundations shall be neatly chamfered by means of sheet metal or triangular wood strips nailed to the form. Foundation bolts shall be placed in the forms when the concrete is poured, the bolts being correctly located by means of templates. Each bolt shall be set in a sleeve of size to provide 1/2" clearance around bolt. Allow 1" below the equipment bases for alignment and grouting. After grouting, the forms shall be removed and the surface of the foundations shall be hand rubbed with Carborundum. Foundations for equipment located on the exterior of the building shall be provided as indicated. Foundations shall be constructed in

accordance with Shop Drawings submitted by the Contractor for review by the Architect/Engineer.

19.05 WALL, FLOOR AND CEILING PLATES

- A. Except as otherwise noted, provide C.P. (Chrome plated) brass floor and ceiling plates around all pipes, conduits, etc., passing exposed through walls, floors, or ceilings, in any spaces except under floor and attic spaces. Plates shall be sized to fit snugly against the outside of the pipe or against the insulation on lines which are insulated and positively secured to such pipe or insulation. Plates will not be required for piping where pipe sleeves extend 3/4" above finished floor. All equipment rooms are classified as finished areas. Round and rectangular ducts shall have closure plates (NOT chrome plated) made to fit accurately at all floor, wall and ceiling penetrations. Floor penetrations in exposed (except in stair wells) areas shall be finished using 'bell' fitting to fit pipe or insulation and sleeve and shall be painted to match the pipe. Penetrations in stairwells shall have flat floor plate painted to match pipe.

19.06 SLEEVES

- A. Provide sleeves for all pipe penetrations through walls, roof or slab above grade.
- B. Set sleeves in position in formwork. Provide reinforcing around sleeves.
- C. Extend sleeves through floors 2 inches (50.8 mm) above finished floor level. Caulk sleeves full depth and provide floor plate.
- D. Where piping or ductwork penetrates floor, ceiling wall, close off space between pipe or duct and adjacent work with fire stopping insulation and seal air tight. Provide close fitting metal collar or escutcheon covers at both sides of penetration. When penetration is through a fire rated floor or wall, provide fire safe insulation so that the assembly, when complete, is UL listed and equals the fire rating of construction penetrated by the sleeve.
- E. Install chrome plated steel escutcheons at finished surfaces.
- F. Provide three 6 inch (152.4 mm) long reinforcing rods welded at 120-degree spacing to the sleeve on all sleeves supporting riser piping 4 inches (101.6 mm) and larger. Embed reinforcing rods in concrete or grout to existing concrete.
- G. Install sleeve assembly for walls below grade with 1/4-inch thick plate located in the middle of the wall.
- H. Neatly cut hose in existing walls, floors and roofs for placement of sleeves. Place sleeve and grout, and caulk annular space to provide finished appearance.
- I. Install pipe in sleeve so that neither the pipe nor its insulation touches the sleeve at any point.
- J. Seal space between pipe and sleeve watertight for all sleeves penetrating the roof.

19.07 SLEEVES

- A. General: All openings through all floors, walls, and roofs, etc., regardless of material for the passage of piping, ductwork, conduit, cable trays, etc., shall be sleeved. All penetrations must pass through sleeves. Sleeves shall be set in new construction before concrete is poured, as cutting holes through any part of the concrete will not be permitted unless acceptable to the Architect/Engineer. If a penetration is cored into an existing vertical solid concrete, masonry or stone structure, then the installation of a sleeve will not be necessary.
 - 1. Sleeve material for floors and exterior walls shall be Schedule 40 galvanized steel with welded water stop rings.
 - 2. Sleeves through interior walls to be galvanized sheet metal with gauge as required by wall fire rating, 20 gauge minimum.
- B. The minimum clearance between horizontal penetrations including insulation where applicable, and sleeve shall be 1/4", except that the minimum clearance shall accommodate a Thunderline Link-seal closure where piping exits the building, or penetrates a wall below ground level.

Contractor shall be responsible for the accurate location of penetrations in the slab for his pipe, duct, etc. All penetrations shall be of ample size to accommodate the pipe, duct, etc., plus any specified insulation. Void between sleeve and pipe in interior penetrations shall be filled with Nelson Flameseal Firestop or approved equal caulk or putty.

- C. Floor sleeves shall extend above the finished floor as detailed on the drawings, except that floor sleeves in stairwells shall be flush with the finished floor. Sleeves in walls shall be trimmed flush with wall surface. Refer to the details on the project drawings. Where the details differ from these specifications, the drawings take precedence.
- D. Sleeves for penetrations passing through walls or floors on or below grade shall be removed, if practical, and after the pipes have been installed, the void space around the pipe shall be caulked with a suitable material to effect a waterproof penetration. Note that the practicality of the removal of the sleeve shall be the decision of the Construction Inspector. The decision of the Inspector shall be final.
- E. Vermin proofing: The open space around all ductwork, piping, etc., passing through the ground floor and/or exterior walls shall be vermin proofed in a manner acceptable to the Architect/Engineer.
- F. Waterproofing: The annular space between a pipe and its sleeve in interior floors shall be filled with polyurethane foam rods 50 percent greater in diameter than the space as backing and fill material and made watertight with a permanent elastic polysulfide compound. Seal both surfaces of floor.
- G. Air Plenums: The space around piping, ductwork, etc., passing through air plenums shall be made airtight in a manner acceptable to the Architect/Engineer.
- H. Fireproofing: Seal all cable trays, pipe, conduit, duct, etc., penetrations through roof, fire rated walls and floors with a foam or sealant as described below, that will form a watertight, vermin tight barrier that is capable of containing smoke and fire up to 2000° F for two hours. Sealing of cable trays and conduits that extend through rated walls from ends of cable tray shall be done after conductors have been installed. For wet locations, the foam material shall be silicone RTV foam or an approved equal. For dry locations, premixed putty equal to Nelson Flameseal Firestop putty may be used.

19.08 ANCHOR BOLTS

- A. Locate position of anchor bolts by means of suitable templates.
- B. When equipment is placed on vibration isolators, secure equipment to the isolator and the isolator to the floor, pad or support as recommended by the vibration isolator manufacturer.

19.09 INSULATION SHIELDS

- A. Provide insulation shields at every hanger support.
- B. Provide shields of the proper length to distribute weight evenly and to prevent sagging or indentation of insulation at hanger.
- C. Install shield so that hanger is placed at the center of the shield.
- D. Attach shield to insulation with adhesive to prevent slippage or movement.
- E. Supports, hangers, anchors and guides shall be provided for all horizontal and vertical piping. Shop Drawings shall be provided, indicating locations and details of anchors, guides, expansion loops and joints, hangers, etc. The hanger design shall conform to the ASME Code for Pressure Piping.
- F. All auxiliary steel required for supports, anchors, guides, etc. shall be provided by the Mechanical Trades unless specifically indicated to be provided by others.

- G. The supports, hangers, anchors, and guides for the chilled water supply and return piping, steam piping, condensate return piping, etc. of the Campus Loop System routed through utility tunnels and below buildings shall be provided as indicated on the Drawings.
- H. Contractor shall review all Drawings, including Structural Drawings, for details regarding pipe supports, anchors, hangers, and guides.
- I. All Supports shall be of type and arrangement to prevent excessive deflection, to avoid excessive bending stresses between supports, and to eliminate transmission of vibration.
- J. All rod sizes indicated in this Specification are minimum sizes only. This trade shall be responsible for structural integrity of all supports, anchors, guides, etc. All structural hanging materials shall have a minimum safety factor of 5 built in.
- K. Anchor points as indicated on Drawings or as required shall be located and constructed to permit the piping system to take up its expansion and contraction freely in opposite directions away from the anchored points.
- L. Guide points shall be located and constructed wherever required or indicated on Drawings and at each side of an expansion joint or loop, to permit free axial movement only.
- M. Supports, hangers, anchors, and guides shall be fastened to the structure only at such points where the structure is capable of restraining the forces in the piping system.
- N. K. Hangers supporting and contacting brass or copper lines 3" in size and smaller shall be Grinnell Fig. CT-99c, adjustable, copper plated, tubing ring. Hangers supporting and contacting brass or copper lines 4" and larger shall be Grinnell Fig. 260, adjustable clevis, with a nut above and below the hanger, and approved neoprene isolating material between pipe (or tubing) and hanger on the support rod. For insulated copper or brass domestic water lines, hangers for all sizes of pipe shall be Grinnell Fig. 300, adjustable clevis, with a nut above and below the hanger, and approved neoprene isolating material between pipe (or tubing) and hanger on the support rod. Isolate all copper or brass lines from all ferrous materials with approved dielectric materials. Hangers supporting and contacting plastic or glass piping shall be of equal design, but shall be padded with neoprene material or equal. The padding material and the configuration of its installation shall be submitted for approval.
- O. Hangers supporting insulated lines where the outside diameter of the insulation is the equivalent of 8" diameter pipe or smaller in size and supporting all ferrous lines 6" and smaller in size shall be Grinnell Fig. 260, adjustable clevis, with a nut above and below the hanger on the support rod.
- P. Hangers supporting and contacting ferrous lines larger than 6" in size and outside of insulation on lines with the outside diameter equivalent to 10" diameter pipe shall be Grinnell Fig. 260, adjustable clevis, with a nut shields as specified in Section 23 07 19 - PIPING INSULATION. Protect insulation from crushing by means of a section of rigid insulation to be installed at hanger points. Hangers for high temperature insulated pipes and all insulated hot and cold domestic water pipes shall be encased in the insulation unless supported by trapezes in which case shield and rigid insulation shall be provided as specified above for low temperature insulated pipes.
- Q. Supports for vertical piping in concealed areas shall be double bolt riser clamps, Grinnell Fig. 261, or other approved equal, with each end having equal bearing on the building structure, and located at each floor. Two-hole rigid pipe clamps at 4 feet (121.92 cm) o.c. or Kindorf channels and Grinnell Fig. 261 riser clamps may be used to support pipe directly from vertical surfaces or members where lines are not subject to expansion and contraction. When piping is subject to expansion and contraction, provide spring isolators (see Section 23 05 48 - Vibration Isolation). Where brass or copper lines are supported on trapeze hangers or Kindorf channels the pipes

shall be isolated from these supports with plastic tape with insulating qualities, or strut clamps as manufactured by Specialty Products Company, Stanton, California.

- R. Supports for vertical piping in exposed areas (such as fire protection standpipe in stairwells) shall be attached to the underside of the building structure above the top of the riser, and the underside of the penetrated structure. The contractor shall use a drilled anchor as specified above, and use a Grinnell No. 595 Socket Clamp with Grinnell No. 594 Socket Clamp Washers, as a riser clamp. The top riser hanger shall consist of two (2) hanger rods (sized as specified) anchored to the underside of the building structure, supporting the pipe by means of the material specified. Risers penetrating floors shall be supported from the underside of the penetrated floor as specified for the top of the riser.
- S. Pipe Supports in Chases and Partitions: Horizontal and vertical piping in chases and partitions shall be supported by hangers or other suitable support. Pipes serving plumbing fixtures and equipment shall be securely supported near the point where pipes penetrate the finish wall. Supports shall be steel plate, angles, or special channels such as Unistrut mounted in vertical or horizontal position. Pipe clamps such as Unistrut P2426, P2008, P1109 or other approved clamps shall be attached to supports. Supports shall be attached to wall or floor construction with clip angles, brackets, or other approved method. Supports may be attached to cast iron pipe with pipe clamp, or other approved method. All copper or brass lines shall be isolated from ferrous metals with dielectric materials to prevent electrolytic action.
- T. All electrical conduits shall be run parallel or perpendicular to adjacent building lines. Single conduits running horizontally shall be supported by "Caddy" or "Minerallac" type hangers from adequately sized rods (minimum 1/4") from the building structure. Where multiple conduits are run horizontally, they shall be supported on trapeze of "Unistrut" type channel suspended on rods or bolted to vertical building members. Conduit shall be secured to channel with galvanized "Unistrut" type conduit clamps or stainless steel "Unistrut" type "Uni-Clips". All hangers shall be fastened to the building structure in the same manner as specified above for pipe hangers above and below the hanger on the support rod.
- U. Other special type of hangers may be employed where so specified or indicated on the Drawings, or where required by the particular conditions. In any case, all hangers must be acceptable to the owner.
- V. Each hanger shall be properly sized to fit the supported pipe or fit the outside of the insulation on lines where specified. Hangers for dual or low temperature insulation pipes shall bear on the outside of the insulation, which shall be protected by support
- W. Spacing of hangers shall be adequate for the weight and rigidity of the conduits involved; in any case, no greater than 8' centers. Where feasible, conduits may be fastened to the concrete by one hole straps thoroughly anchored to the concrete in an approved manner. Flexible conduit shall also be supported in an acceptable manner so as not to interfere with the maintenance of above ceiling equipment, and to support it from touching the ceiling system. Conduit shall be located so as not to inhibit removal of ceiling tiles.

END OF SECTION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Furnish and install vibration isolators for rotary, dynamic, or reciprocating equipment or components; include:
 - 1. Inertia bases
 - 2. Vibration isolation

1.02 RELATED SECTIONS:

- A. Section 013300 Submittals.
- B. Section 01524 Construction Waste Management

1.03 REFERENCES

- A. ASHRAE – Guide to average Noise Criteria Curves
- B. Local codes and ordinances
- C. Special conditions

1.04 SUBMITTALS

- A. Indicate isolation base dimensions.
- B. Indicate vibration isolator locations, with static and dynamic load.
- C. Include calculation required to certify compliance with specified requirements.
- D. Submit manufacturer's certificate that isolators are properly installed and properly adjusted to meet or exceed specified requirements.
- E. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:
 - 1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.

1.05 QUALITY ASSURANCE

- A. Maintain ASHRAE criteria for average noise criteria curves for all equipment at full load condition.
- B. Provide vibration isolation devices, including auxiliary steel bases and pouring forms, from a single manufacturer or supplier who will be responsible for complete coordination of all phase of this work.

1.06 INTENT OF RESPONSIBILITY

- A. It is the intent of this specification to provide for vibration isolation supports for all equipment, piping, and ductwork as set out below. The transmission of perceptible vibration, structural borne noise, or objectionable air borne noise to occupied areas by equipment installed under this contract will not be permitted. The Contractor shall be held responsible for installing the vibration isolators as specified herein or shown on the drawings or otherwise required to prevent the transmission of vibration which would create objectionable noise levels in occupied areas. The isolation supplier must be a firm capable of dealing effectively with vibration and noise characteristics effects and criteria, and one which can provide facilities and capabilities for measuring and evaluating the aforementioned disturbances.
- B. All vibration isolation devices, including auxiliary steel bases and pouring forms, shall be designed and furnished by a single manufacturer or supplier who will be responsible for adequate coordination of all phases of this work. Concrete housekeeping pads and inertia bases shall be included as part of mechanical work. Pads under electrical gear shall be

included as part of electrical work. The concrete work shall meet the requirements specified in the General Contract Specifications.

- C. The Contractor shall furnish complete submittal data, including Shop Drawings, which shall indicate the size, type, and deflection of each isolator; and the supported weight, disturbing frequency, and efficiency of each isolator proposed; and any other information as may be required for the Architects and Engineers to check the isolator selection for compliance with the specification. All steel bases and concrete inertia bases shall be completely detailed, and shall show completely any reinforcing steel that may be required to provide a rigid base for the isolated equipment. Further, the submittal data shall indicate, clearly, outlined procedures for installing and adjusting the isolators and bases mentioned above.
- D. The vibration isolation manufacturer, or his qualified representative, shall be responsible for providing such supervision as may be required to assure correct and complete installation and adjustment of the isolators. Upon completion of the installation and after the system is put into operation and before acceptance by the Owner, the isolation manufacturer or his qualified representative, in company with the Architect or his designated representative, shall make a final inspection and submit his report to the Architects and Engineers, in writing, certifying the correctness of the installation and compliance with approved submittal data. Any discrepancies or maladjustments found shall be so noted in the report. Should any noise or vibration be objectionable to the Owner, Architect or Engineer, a field instrumentation test and measurement must be made to determine the source, cause, and path of any such disturbance. Any variation or noncompliance with these specification requirements is to be corrected by the installing contractor in an approved manner.
- E. Vibration isolation devices shall be as manufactured by Amber/Booth Company, Consolidated Kinetics, Korfund Dynamics Corporation, or approved equal.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Amber-Booth Company
- B. Mason Industries, Inc.
- C. Noise Control, Inc.

2.02 GENERAL DESIGN FEATURES

- A. Provide vibration isolation for all mechanical equipment. Provide inertia bases for all equipment mounted on upper floors.
- B. All vibration isolators and bases furnished by the Contractor shall be designed for and treated for resistance to corrosion.
- C. Steel components shall be PVC coated or phosphated and painted with industrial grade enamel. All nuts, bolts and washers shall be zinc-electroplated or cad-plated. Structural bases shall be thoroughly cleaned of welding slag and primed with zinc-chromate or metal etching primer. A finish coat of industrial grade enamel shall be applied over the primer.
- D. All isolators exposed to the weather shall have steel parts PVC coated, hot-dip galvanized or zinc-electroplated plus coating of Neoprene or Bitumastic paint. Aluminum components for outdoor installation shall be etched and painted with industrial grade enamel.
- E. Required spring deflections for isolators supporting various items of equipment are shown on the Drawings or tabulated elsewhere in these specifications, but in no case shall be less than one inch. The springs shall be capable of 30% over-travel before becoming solid.
- F. Where height-saving brackets for side mounting of isolators are required, the height-saving brackets shall be designed to provide for an operating clearance of 2" under the isolated structure, and designed so that the isolators can be installed and removed when the operating

clearance is 2" or less. When used with spring isolators having a deflection of 2-1/2" or more, the height-saving brackets shall be of the pre-compression type to limit exposed bolt length between the top of the isolator and the underneath side of the bracket.

- G. All isolators supporting a given piece of equipment shall limit the length of the exposed adjustment bolt between the top and base to a maximum range of 1" to 2".
- H. All isolators supporting a given piece of equipment shall be selected for approximately equal spring deflection.
- I. Isolators for equipment installed out-of-doors shall be designed to provide adequate restraint due to normal wind conditions and to withstand wind load of 55 PSF (pounds per square foot) applied to any exposed surface of the equipment without failure.

2.03 ISOLATION BASES

- A. Type A: Integral structural steel fan and motor base with motor slide rails.
- B. Type B: Slung structural steel base with gusseted brackets.
- C. Type C: Reinforced 3,000 psi (20684.28 kPa) concrete set in full depth perimeter structural steel channel frame, with gusseted brackets and anchor bolts.
- D. Type D: Reinforced 3,000 psi (20684.28 kPa) concrete base with chamfered edges without channel frame.

2.04 BASE TYPES: BASE TYPES AND REQUIRED DEFLECTIONS ARE SPECIFIED UNDER "SCHEDULE OF ISOLATED EQUIPMENT," PARAGRAPH 7.8, OR ARE INDICATED ON THE DRAWINGS. THE BASES SHALL COMPLY WITH THE FOLLOWING DESCRIPTIONS FOR EACH TYPE REQUIRED ON THE PROJECT.

- A. Type B-1 - A structural steel fan and motor base with motor side rails and holes drilled to receive the fan and motor. The steel members shall be adequately sized to prevent distortion and misalignment of the drive, and specifically shall be sized to limit deflection of the beam on the drive side to 0.05" due to starting torque. Snubbers to prevent excessive motion on starting or stopping shall be furnished, if required; however, the snubbers shall not be engaged under steady running conditions.
- B. Type B-2 - A concrete inertia base, consisting of a perimeter steel pouring forming, reinforcing bars welded in place, bolting templates, anchor bolts, and height saving brackets for side mounting of the isolators. The perimeter steel members shall be structural channels having a minimum depth of 1/12 of the longest span, but not less than 6" deep. The inertia base for pumps shall be at least equal in weight to the pump with its driving motor and be sized for a minimum overlap of 4" around the base of the equipment. Concrete inertia bases for pumps shall be sized to support the suction elbow of end suction pumps and both the suction and discharge elbows of horizontal split case pumps. The bases shall be T-shaped where necessary to conserve space.

2.05 VIBRATION ISOLATORS

- A. Type 1 - An adjustable, free-standing, open-spring mounting with combination leveling bolt and equipment fastening bolt. The spring(s) shall be rigidly attached to the mounting base plate and to the spring compression plate. The isolator shall be designed for a minimum Kx/Ky (horizontal to vertical spring rate) of 1.0. A Neoprene pad having a minimum thickness of 1/4" shall be bonded to the base plate. Base plates shall be sized to limit pad loading to 100 psi (689.48 kPa).
- B. Type 2 - An aluminum-housed, or cast iron housed, adjustable, spring mounting having telescoping top and bottom sections separated by resilient inserts of Neoprene or other

suitable material to limit horizontal motion. The inserts shall be permanently lubricated to minimize vertical friction. Sheet or cast iron housings may be used if they are hot-dip galvanized after fabrication. A Neoprene pad having a minimum thickness of 1/4" shall be bonded to the base plate.

- C. Type 3 - An elastomeric mounting having steel base plate with mounting holes and a threaded insert at top of the mounting for attaching equipment. All metal parts shall be completely embedded in the elastomeric materials. The elastomer may be Neoprene or high synthetic rubber with anti-ozone and anti-oxidant additives. Mountings shall be designed for approximately 1/4" deflection and loaded so that deflection does not exceed 15% of the free height of the mounting.
- D. Type 4 - A pad-type mounting consisting of two layers of 3/8" thick, ribbed or waffled, Neoprene pads bonded to a 16 gauge galvanized steel separator plate. Bolting not required. Pads shall be sized for approximately 20 to 40 psi (275.79 kPa) load, or a deflection of 0.10" to 0.16".
- E. Type 5 - A spring hanger consisting of a rectangular steel box, coil springs, spring cups, Neoprene impregnated fabric washer, steel washer, and Neoprene insert designed to prevent metal to metal contact between the hanger rod and bottom of the hanger box. The hanger box shall be capable of supporting a load of 200% of rated load without noticeable deformation or failure.
- F. Type 6 - A spring hanger, as described in Type 5, with the addition of an elastomeric element at the top of the box for acoustic isolation. The design shall be such to prevent metal - to metal contact between the hanger rod and the top of the hanger box. The elastomeric element shall meet the design requirements for Type 3 mountings.
- G. Type 7 - An elastomeric hanger, consisting of a rectangular steel box and an elastomeric isolation element, which shall be of Neoprene or high quality synthetic rubber with anti-ozone and anti-oxidant additive. The elements shall be so designed for approximately 1/4" deflection and loaded so that deflection does not exceed 15% of the free height of the element. The design shall be such as to prevent metal-to-metal contact between the hanger rod and the steel box.

2.06 FABRICATION

- A. Provide pairs of neoprene side snubbers or restraining springs where side torque or thrust may develop.
- B. Color code spring mounts.
- C. Select spring to operate at two-thirds maximum compression strain, with 1/4 inch (6.35 mm) ribbed neoprene pads.
- D. Type 1 Isolators: Fabricate with cast aluminum or hot-dipped galvanized steel housing with PVC coated steel spring and neoprene pad bonded to base plate.

2.07 VIBRATION ISOLATION ROOF CURBS FOR ROOF MOUNTED UNITS

- A. Description: Factory-assembled, fully enclosed, insulated, air- and watertight curb designed to resiliently support roof-mounted equipment and to withstand 125-mph wind impinging laterally against the side of the equipment.
 - 1. Components: Upper support frame; lower support assembly; freestanding, un-housed, laterally stable steel springs; vertical and horizontal restraints.

2. Lower Support Assembly: Provide a means of attachment to the building structure and include a wood nailer stripe for attachment of roof material and 2 inches (50.8 mm) of rigid insulation on the inside of the assembly.
3. Spring Isolators: As indicated or scheduled. Include adjustment bolt to permit leveling of equipment after installation. Attach to lower assembly with a rubber isolation pad. Locate spring isolators so they are accessible for adjustment at any time during the life of the installation without interfering with the integrity of the roof.
4. Water Seal: Elastomeric seal conforming to UL Class A roofing materials, attached to the upper support frame, extending down past the wood nailer of the lower support assembly, and counter flashed over the roof materials.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install vibration isolators for motor driven equipment.
- B. Set steel bases for 1 inch (25.4 mm) clearance between housekeeping pad and base. Set concrete inertia bases for 2 inch (50.8 mm) clearance. Adjust equipment level.
- C. Provide spring isolators on piping connected to isolated equipment as follows:
 1. Up to 4 inch (101.6 mm) diameter, first three points of support; five to 8 inch (203.2 mm) diameter, first four points of support;
 2. 10 inch (254 mm) diameter and over, first six points of support. Static deflection of first point to be twice deflection of isolated equipment.
- D. Provide minimum of four hangers for each fan coil unit and fan powered terminal units. Provide isolators for each hanger.

3.02 SCHEDULE

ISOLATED EQUIPMENT	BASE TYPE	ISOLATOR TYPE
AIR HANDLING UNITS	B-1	1
FLOOR MOUNTED		
CENTRIFUGAL FANS	B-1	1
CLASS I & II TO 54 INCHES (1371.6 MM)		
CLASS I & II OVER 60 INCHES (1524 MM)		
CLASS III	B-2	1
CHILLERS (GRADE MOUNTED)	B-2	1
ROOF MOUNTED AHU	CONCRETE PAD	4
OTHER THAN SLAB ON GRADE		
PUMPS	B-2	1
3 HP & SMALLER		
5 HP & OVER	B-1	7
PIPING	B-2	2
ISOLATED EQUIPMENT		5
DUCTWORK	BASE TYPE	ISOLATOR TYPE
		N/A

FAN POWERED TERMINAL UNITS	6
FAN COIL UNITS	6

END OF SECTION

PART 1 GENERAL

1.01 REFERENCE STANDARDS

- A. ASME A13.1 - Scheme for the Identification of Piping Systems; 2023.
- B. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2024.

1.02 RELATED DOCUMENTS

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

1.03 SUMMARY

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

1.04 RELATED SECTIONS

- A. Section 09 01 90 – Maintenance of Painting and Coatings.

1.05 REFERENCES

- A. ANSI A13.1 - Scheme for the Identification of Piping Systems.
- B. UMC - Uniform Mechanical Code, 2021 edition with City of Pflugerville, Texas amendments.
- C. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.

1.06 SUBMITTALS

- A. Submittals in this article are defined in Division 01 Section "Submittal Procedures" as "Action Submittals."
- B. Submit under provisions of Section 23 05 00.
- C. Submit list of wording, symbols, letter size, and color coding for mechanical identification.
- D. Product Data: Provide manufacturers' catalog literature for each type of product required, including:
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Installation methods.
- E. Samples: Submit two (2) of each type of label, tag, etc., of the approximate size specified or implied in the Specification for color, letter style, and graphic representation required.
- F. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- G. Shop Drawings: Submit list of wording, symbols, letter size, and color coding for plumbing equipment, piping and valve identification.
 - 1. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
 - 2. Access Panel and Door Markers: Provide a schedule of all panels and doors to be labeled with the proposed content for each label.
 - 3. Pipe Label Schedule: Provide a schedule of each piping systems indicating a proposed nomenclature and location of all pipe markers.
- H. Valve Chart and Schedule: Provide a proposed valve numbering scheme and schedule for each piping system, including valve tag number, location, function, and valve manufacturer's

name and model number, piping system, system abbreviation as shown on tag, normal-operating position (open, closed, or modulating), and variations for identification, to include in maintenance manuals. Mark valves intended for emergency shut-off and similar special uses.

- I. Warning Tags: Provide a schedule of all equipment to be labeled with the proposed content for each label.
- J. Manufacturer's Installation Instructions: Indicate special procedures, and installation.

1.07 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

1.08 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Section 23 05 00.
- B. Record actual locations of tagged valves.

1.09 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum five (5) years documented experience
- B. Installer Qualifications: Company specializing in performing Work of this section with minimum five (5) years documented experience.
- C. ASME Standards: Comply with ASME A13.1 for color scheme, lettering size, length of color field, and viewing angles of identification devices.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging with labels clearly identifying product name and manufacturer until ready for installation.
- B. Storage: Store materials in clean, dry area indoors until ready for installation.
- C. Handling: Protect materials and finish from damage during handling and installation.

PART 2 PRODUCTS

2.01 GENERAL

- A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.
- B. Make it possible for the personnel operating and maintaining the equipment and systems in this project to readily identify the various pieces of equipment, valves, piping, etc., by marking them. All items of equipment such as fire pumps, etc., are to be clearly marked using engraved nameplates as specified. Use equipment identification numbers that appear on the design documents and/or equipment identification numbers furnished by the Owner's Designated Representative.
- C. General: Provide manufacturer's standard products of categories and types required for each application specified. For each identification type, provide all products from same manufacturer with same text, style, color, shape, and other identification features.
 - 1. Provide nameplates with the unit number on all plumbing equipment.
 - 2. Access panel and door markers for valve cabinets, etc.
 - 3. Provide pipe identification labels including direction-of-flow arrows and with service indicated. All labels shall have background colors matched with specific service designation.
 - 4. Provide valve tag numbers on all valves.

5. Warning tags at motors and equipment controlled by automatic starters, etc.

2.02 MANUFACTURERS

- A. Equipment Tags, Valve Tags, and Markers:
 1. Brady Corporation.
 2. Brimar Industries.
 3. Craftmark.
 4. Marking Systems, Inc.
 5. Seton, owned by Brady Corporation.
 6. Graphic Products, Inc.

2.03 MATERIALS

- A. Color: Meet requirements of ANSI A13.1, unless specified otherwise.

2.04 EQUIPMENT LABELS

- A. Plastic Labels for Equipment:
 1. Material and Thickness:
 - a. Indoors: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.18 mm) thick, and having predrilled holes for attachment hardware.
 - b. Outdoors: Chemically resistant plastic with printed graphics protected by a chemical and UV resistant top laminate.
 2. Letter Color: White.
 3. Background Color: Black.
 4. Maximum Temperature: Able to withstand temperatures up to 160 degrees Fahrenheit (71.11 degrees Celsius).
 5. Minimum Label Size: Length and width vary for required label content, but not less than 1 by 3 inches (76.2 mm).
 6. Minimum Letter Size: 1/4 inch (6.35 mm) for name of units if viewing distance is less than 24 inches (609.6 mm), 1/2 inch (12.7 mm) for viewing distances up to 72 inches (1828.8 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds (2/3) to three-fourths (3/4) the size of principal lettering.
 7. Fasteners: Stainless-steel self-tapping screws.
- B. Label Content: Nomenclature on the label is to include the name of the item, its mark number, area, space, or equipment served, and other pertinent information. Use equipment identification numbers that appear on the design documents and/or equipment identification numbers furnished by the Owner..
- C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.
- D. All scheduled equipment shall be identified with an Equipment Tag.

2.05 ACCESS PANEL AND DOOR MARKERS

- A. Material and Thickness: 1/8-inch- thick, engraved laminated plastic, with abbreviated terms and numbers corresponding to identification.
- B. Letter Color: White
- C. Background Color: Black
- D. Fasteners: Self-tapping, stainless steel screws or contact-type, permanent adhesive.

2.06 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.18 mm) thick, and having predrilled holes for attachment hardware.
- B. Letter Color: White.
- C. Background Color: Red.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (19.05 mm).
- F. Minimum Letter Size: 1/4 inch (6.35 mm) for name of units if viewing distance is less than 24 inches (609.6 mm), 1/2 inch (12.7 mm) for viewing distances up to 72 inches (1828.8 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- G. Fasteners: Stainless-steel self-tapping screws.
- H. Label Content: Include caution and warning information, plus emergency notification instructions.

2.07 PIPE LABELS (INDOOR PIPING)

- A. Provide labels for above ground piping located indoors, and not exposed to sunlight or a harsh environment.
- B. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction in conformance with ANSI A13.1.
- C. Plastic Labels for Pipe O.D. less than 8 inches (203.2 mm): Pre-coiled, semi-rigid plastic formed to cover full circumference of pipe or pipe covering and to attach to pipe without fasteners or adhesive in contact with the pipe surface.
- D. Pipe Labels for Pipe O.D. 8 inches (203.2 mm) and Over: Strap-on, semi rigid plastic to cover partial circumference of pipe and to attach to pipe with nylon ties.
 - 1. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
 - 2. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
 - 3. Lettering Size: At least 1-1/2 inches (38 mm) high.
- E. Pipe markers and arrow markers also shall be provided for all piping systems.

2.08 PIPE LABELS (OUTDOOR PIPING)

- A. Provide labels for above ground piping located outside, and exposed to sunlight or a harsh environment, the following product is specified.
- B. Pre-printed, color-coded, with lettering indicating service, and showing flow direction.
- C. Pipe markers shall be constructed of printed 5 mil (0.127 mm) polyester and top laminated with ultraviolet and chemical resistant plastic film that is engineered to provide maximum durability of the printed legend. Markers shall be pre-coiled to wrap entirely around the circumference of pipe up to 10 inch outside diameter, and self-sealed with a strip of clear ultraviolet and chemical resistant plastic film. Coiled markers shall seal to themselves, and not the pipe surface.
- D. Pipe Labels for pipe O.D. up to 10 inches (254 mm): Shall be labeled with a single piece, pre-printed marker that wraps entirely around the circumference of the pipe, overlaps and seals to itself rather than adhere to the pipe surface.
- E. Pipe Labels for pipe O.D. 10 inches and greater: Shall be constructed of printed 5 mil (0.127 mm) polyester and top laminated with clear ultraviolet and chemical resistant plastic film that is pre-applied to an acrylic-faced, co-extruded ABS plastic carrier. Carrier shall have pre-formed

legs running the entire length of the part to ensure marker remains straight and aligned with pipe. Flow direction shall be identified by application of a separate arrow label of same construction. Carriers shall be affixed to piping by means of two (2) stainless steel straps that wrap entirely around the circumference of the pipe.

- F. Underground Plastic Pipe markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil (0.1016 mm) thick, manufactured for direct burial service.

2.09 VALVE TAGS

- A. Provide and install identification tags lettered and numbered to correspond to the information shown on the charts described above.
- B. Valve tags shall conform to ANSI A13.1.
 - 1. Valve Tags (Indoor): Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
 - 2. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 - 3. Background Color: Natural brass.
 - 4. Letter Color: Black.
 - 5. Tag Size: 1-1/2 inches (38 mm), round.
 - 6. Fasteners: Brass S-hooks and Jack chain
- C. Valve Tags (Outdoor):
 - 1. Material: Chemically resistant plastic with printed graphics protected by a chemical and UV resistant top laminate, and having stainless steel grommet protected predrilled holes with for attachment hardware.
 - 2. Background Color: Red.
 - 3. Letter Color: White.
 - 4. Tag Size: Minimum 1-1/2 inches (38 mm).
 - 5. Fasteners: Stainless steel S-Hooks and stainless steel Jack Chain.
- D. Valve Schedules:
 - 1. For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
 - 2. Valve-tag schedule shall be included in operation and maintenance data.

2.10 CEILING TACKS

- A. Description: Steel with 3/4 inch (19.05 mm) or 7/8" diameter color coded head.
- B. Color code: Red.

2.11 CEILING GRID TAG FOR EQUIPMENT LOCATED ABOVE LAY-IN CEILING

- A. Description: 3/4" x variable length vinyl label, 3.0 mil (0.0762 mm) self-adhesive vinyl similar to Graphic Products, Inc. DuraLabel Pro™. Label color shall be black text on a white background.
- B. All scheduled equipment above finish lay-in ceiling shall be identified with an Equipment Tag.
- C. All ceiling grid tags shall be installed prior to the ceiling cover inspection.

2.12 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.18 mm) thick, and having predrilled holes for attachment hardware.
- B. Letter Color: White.
- C. Background Color: Red.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (19.05 mm).
- F. Minimum Letter Size: 1/4 inch (6.35 mm) for name of units if viewing distance is less than 24 inches (609.6 mm), 1/2 inch (12.7 mm) for viewing distances up to 72 inches (1828.8 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds (2/3) to three-fourths (3/4) the size of principal lettering.
- G. Fasteners: Stainless-steel self-tapping screws.
- H. Label Content: Include caution and warning information, plus emergency notification instructions.

2.13 WARNING TAGS

- A. Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
- B. Size: 3 by 5-1/4 inches (133 mm) minimum.
- C. Fasteners: Reinforced grommet and wire or string.
- D. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
- E. Color: Yellow background with black lettering.

2.14 PAINT

- A. Material Compatibility: Provide primers, undercoat, finish coat, and related materials that are compatible with one another and the substrates indicated under conditions of service and application, as demonstrated by the manufacturer based on testing and field experience.
- B. Material Quality: Sherwin-Williams Paint.
 - 1. Provide Sherwin-Williams highest-quality trade sale paint material of the various coating types specified. Paint material containers not displaying manufacturer's product identification will not be acceptable.
 - 2. Furnish the manufacturer's material data and certificates of performance for proposed situations.
 - 3. Provide primer and undercoat materials with a minimum six (6) months guaranteed life against fade and/or color bleed-through.
- C. Colors: Provide color samples to the Architect/Engineer for selection from the manufacturer's full range of standard colors.
- D. Primers: Provide the manufacturer's recommended factory-formulated primers that are compatible with the substrate and finish coats indicated.
 - 1. Galvanized Metal Primers: One (1) coat of Sherwin-Williams Kem Kromic Universal Metal Primer.
- E. Undercoat Materials: Provide the manufacturer's recommended factory-formulated undercoat materials that are compatible with the substrate and finish coats indicated.
 - 1. Galvanized Metal Interior Enamel Undercoat:
 - a. One (1) coat of Sherwin-Williams DTM Alkyd Enamel: Finish Paint: Provide the manufacturer's recommended factory-formulated finish coated materials that are compatible with the substrate and finish coats indicated.
 - 2. Galvanized Metal Interior, Semi-Gloss, Odorless Alkyd Enamel: Two (2) coats of Sherwin-Williams DTM Alkyd Enamel
 - 3. Cotton or Canvas Covering over Insulation Interior Satin/Egg-Shell Latex Emulsion Size:
 - a. Two (2) coats of Sherwin-Williams Super Paint.
 - b. Two (2) coats of Sherwin-Williams Pre-Catalyzed Water based Epoxy.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. Install identifying devices after completion of coverings and painting.
- C. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

- A. Thoroughly clean all surfaces to be painted as required to remove all oil, grease, loose scale, rust, and foreign matter. Piping must be completely dry at the time of application. The painting of piping associated with an operating system is strictly prohibited. Site touch-up of the factory applied coating or paint, to include preparation and painting of field welds, must be completed and approved by the Engineer prior to installation of insulation (No Exceptions).
- B. For pipe markers that are pre-coiled or strap-on type and do not adhere directly to the piping, no surface preparation is necessary.

3.03 INSTALLATION

- A. Plastic Nameplates: Secure nameplates to equipment fronts using corrosive resistant screws and rivets. Install nameplates parallel to equipment lines.
- B. Metal Tags: Install with corrosive-resistant chain and "j-hook."
- C. Plastic Pipe Markers: Install in accordance with manufacturer's instructions.
- D. Plastic Tape Pipe Markers: Install completely around pipe in accordance with manufacturer's instructions.
- E. Equipment
 - 1. Identify mechanical equipment scheduled on Drawings with nameplates, except for air devices.
 - 2. Identify name, number, function, capacity, and other pertinent information of air handling units, pumps, heat transfer equipment, tanks, and water treatment devices with plastic nameplates.
 - 3. Use identification of equipment on the "Record Drawings" for nameplate designations.
 - 4. Attach identification for items such as special switches, etc., located in finished areas, on or in the immediate vicinity of the item.
- F. Controls: Identify control panels and major control components outside panels with plastic nameplates.
- G. Valves: Identify with metal tags, ALL valves in main and branch piping, connections to equipment, and all run out piping to coils with metal tags.
- H. Fire Dampers: Label with plastic nameplates in accordance with NFPA 90A. Fire Damper locations will be labeled on the wall with plastic nameplates.
- I. VAV Boxes: Label with plastic nameplates. VAV box locations will be labeled on the ceiling with plastic nameplates.
- J. Warning-Tag Installation: Write required message on, and attach warning tags to, equipment and other items where required.
- K. Ceiling Tacks: mark location of equipment or valves located above ceilings with identifying "buttons" to help in identification for maintenance.
- L. Ceiling Grid Tags: Provide ceiling grid tags to locate valves or other concealed equipment above T-bar type panel ceilings. Locate in corner of grid closest to equipment.

3.04 PAINTING

A. Piping:

1. Paint all exposed piping, including insulated piping, in mechanical and equipment rooms and mechanical yards with colors to meet ANSI standards. In addition, identify all piping, concealed or exposed, with plastic pipe markers or plastic tape pipe markers. Identify service, flow direction and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 10 feet (304.8 cm) 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. Provide a flow arrow at each identification marker.
2. Paint all exposed piping, including insulated piping, with DTM Alkyd Enamel primer and undercoat only. Provide color samples to the Architect for selection from the manufacturer's full range of standard colors. Refer to Section 09 01 90 for finish coat compatibility.

B. Ductwork:

1. Paint all exposed ductwork with primer and undercoat only. Provide color samples to the Architect for selection from the manufacturer's full range of standard colors. Refer to Section 09 01 90 for finish coat compatibility.
2. Paint all ductwork, except as indicated above, with stenciled painting. Identify as to air handling unit number, zone number, and area served. Locate identification at air handling unit, at each side of all wall and floor penetrations or enclosures and at each obstruction.
3. Preparation:
 - a. Examine substrates and conditions under which painting is to be performed for compliance with paint application requirements. Surfaces receiving paint must be thoroughly dry before paint is applied.
 - b. Before applying paint or other surface treatments, thoroughly clean substrates of substances that could impair the bond of the various coatings. Remove all oil and grease prior to cleaning. Schedule cleaning and painting so dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.
 - c. Clean and prepare surfaces to be painted according to the manufacturer's instructions for each particular substrate condition and as specified.
 - d. Clean galvanized surfaces with nonpetroleum-based solvents so that the surface is completely free of oil and surface contaminants. Remove pretreatment from galvanized sheetmetal by mechanical methods.
 - e. Do not begin to apply paint until unsatisfactory conditions have been corrected.
 - f. Start of painting will be construed as the Applicator's acceptance of surfaces and conditions within a particular area.
4. Application:
 - a. Apply paint to all ductwork surfaces, as previously indicated, according to manufacturer's directions. Use applicators and techniques best suited for the substrate and type of material being applied.
 - b. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film.
 - 1) Paint colors, surface treatments, and finishes are indicated in the schedules.
 - 2) Provide primers and undercoats that are compatible with finish coats used (No Exceptions).
 - 3) The number of coats and the film thickness required are the same regardless of the application method. Do not apply succeeding coats until the previous coat has cured as recommended by the manufacturer. Sand between applications where sanding is required to produce a smooth even surface according to the manufacturer's directions.

- c. Apply additional coats if undercoats, stains, or other conditions show through finish coat of paint until paint film is of uniform finish, color, and appearance. Provide special attention to ensure that surfaces, including edges, corners, crevices, welds, and exposed fasteners, receive a dry film thickness equivalent to that of flat surfaces.
- d. The term "exposed piping and ductwork surfaces" is defined to include all visible or open-to-view areas, related hangers, supports, diffusers, grilles, and other similar components. Extend coatings in these areas, as required, to maintain the system integrity and provide the desired protection.
- e. Paint interior surfaces of all ducts, where visible through grilles, registers, or diffusers, with a flat, non-specular black paint.
- f. Minimum Coating Thickness: Apply materials no thinner than the manufacturer's recommended spreading rate. Provide the total dry film thickness of the entire system as recommended by the manufacturer or as herein specified, whichever is the greater.
 - 1) Primer: Apply a minimum of two (2) coats with a total dry film thickness of not less than 2.5 mils (0.0635 mm).
 - 2) Undercoat: Apply a minimum of two (2) coats over primer with a total dry film thickness of not less than 2.5 mils (0.0635 mm).
 - 3) Lusterless (Flat) Finish: Apply a minimum of two (2) coats over primer and undercoat with a total dry film thickness not less than 2.5 mils (0.0635 mm).
 - 4) Semi-gloss Finish: Apply a minimum of two (2) coats over primer and undercoat with a total dry film thickness not less than 3.0 mils (0.0762 mm).

3.05 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Substantial Completion.

3.06 VALVE CHART AND SCHEDULE

- A. Provide valve chart and schedule in aluminum frame with clear plastic shield. Install one (1) in each individual equipment room at locations as directed A/E or Owner.
- B. Provide full piping graphics design in aluminum frame with clear plastic shield. Install one (1) in each individual equipment room at locations as directed by A/E or Owner.

3.07 COLOR CODE FOR MARKING PIPE

MATERIAL	BAND	COLOR	LETTERS & ARROWS	LEGEND
BOILER/ HEATING WATER SUPPLY	DK. RED	SW 6871	BLACK	L.T.W.S
BOILER/ HEATING WATER RETURN	LT. RED	SW 6858	BLACK	L.T.W.R
CHILLED WATER SUPPLY	DK. BLUE	SW 4056	WHITE	C.H.W.S.
CHILLED WATER RETURN	LT. BLUE	SW 4054	WHITE	C.H.W.R

3.01 COLOR CODE MARKING SIZES

OUTSIDE DIAMETER OF PIPE COVERING (INCHES)	LENGTH OF COLOR BAND (INCHES)	ARROW LENGTH BY WIDTH (INCHES)	SIZE OF LEGEND LETTERS AND NUMERALS (INCHES)

LESS THAN 1-1/2	8	8 X 2-1/4	1/2
1-1/2 TO 2-3/8	8	8 X 2-1/4	3/4
2-1/2 TO 7-7/8	12	8 X 2-1/4	1-1/4
8 TO 10	24	12 X 4-1/2	2-1/2
OVER 10	32	12 X 4-1/2	3-1/2

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY

- A. Related Sections:
 - 1. Section 013300 Submittals.
 - 2. Section 01524 Construction Waste Management

1.02 RELATED DOCUMENTS

- A. Contract Documents, General Requirements for Building Construction and Related Work, apply to work specified in this section.
- B. Coordinate with Commissioning Requirements indicated in Section 019113. This contractor is responsible to comply with all requirements for the above section.

1.03 SCOPE

- A. An independent Testing, Adjusting and Balancing (TAB) Contractor for the HVAC systems shall be selected by Owner and paid by Contractor and conform as part of this contract. TAB contractor shall not be hired by general contractor or any sub-contractor. Mechanical Contractor shall provide all assistance and information requested by the TAB contractor.
- B. This section provides for the testing and balancing, of all systems and equipment. Refer to section 019113 for commissioning requirements.
- C. These tests are required to determine that all systems and equipment involved may be safely energized and equipment.
- D. Perform tests by and under the supervision of fully experienced and qualified personnel. Advise each respective manufacturer's representative of tests on their equipment.
- E. Record all test data.
- F. Each section of Divisions 22 and 23 that has the products or systems listed herein, incorporate this section by reference and is incomplete without the required tests stated herein.
- G. This Section includes testing, adjusting, balancing HVAC systems and alarm point reporting verification to produce design objectives, including the following:
 - 1. Balancing airflow and water flow within distribution systems, including sub-mains, branches, and terminals, to indicated quantities according to specified tolerances.
 - 2. Adjusting total HVAC systems to provide indicated quantities.
 - 3. Measuring electrical performance of HVAC equipment.
 - 4. Testing, adjusting, and balancing of Hydraulic piping systems.
 - 5. Testing, adjusting, and balancing of refrigerating systems.
 - 6. Measurement of final operating condition of HVAC systems.
 - 7. Sound measurement of equipment operating conditions.
 - 8. Setting quantitative performance of HVAC equipment.
 - 9. Verifying that automatic control devices are functioning properly and perform their intended functions.
 - 10. Calibrating automatic temperature control sensors.
 - 11. Verification of building alarm and alarm remote monitoring.

1.04 QUALIFICATIONS

- A. The independent testing, adjusting, and balancing agency certified by National Environmental Balancing Bureau (NEBB) or by the Associated Air Balance Council (AABC) in those testing and balancing disciplines required for this project, and having at least one Professional Engineer registered in the State in which the services are to be performed, certified by NEBB or AABC as a Test and Balance Engineer.

- B. The Firm shall have operated a minimum of five (5) years under its current Firm name, and shall be in good standing with the State of Texas, Franchise Tax Board. The firm shall submit their full incorporated name, Charter Number and Taxpayer's I.D. Number for proper verification of the firm's status.
- C. The Firm shall be capable of providing a performance bond, by a bonding company licensed to do business in the State of Texas, if determined by the Owner that such a bond is required. The amount of the bond which may be required shall be equal to the cost of the proposal submitted, or in the case of more than one proposal, the sum of all such proposals and any awarded work in progress.
- D. All personnel used on the job site shall be either professional engineers or engineering technicians, who shall have been permanent, full time employees of the firm for a minimum of six (6) months prior to the start of work for this specific project.
- E. The TAB firm shall submit biographical data on the individual proposed who will directly supervise the TAB work, as well as other personnel scheduled to perform the technical work under the contract. It shall also submit a background record of at least five years of specialized experience in the field of air hydronic system balancing, and shall possess properly calibrated instrumentation. The supervisory personnel for the TAB firm shall be registered engineers in the mechanical field and all of the employees used in the TAB firm shall be permanent, full-time employees of the firm.
- F. Pre-Balancing Conference: Prior to beginning of testing, adjusting, and balancing procedures, schedule and conduct a conference with the Engineer and representatives of installers of the mechanical systems. The objective of the conference is final coordination and verification of the system operation and readiness for testing, adjusting, and balancing.
- G. Test, adjust, and balance the air systems before hydraulic, steam, and refrigerant systems.
- H. Test, adjust and balance air conditioning systems during summer season and heating systems during winter season, including at least a period of operation at outside conditions within five degrees Fahrenheit wet bulb temperature of maximum summer design condition, and within ten degrees Fahrenheit dry bulb temperature of minimum winter design condition. Take final temperature reading during seasonal operation.
- I. Approved TAB Contractors:
 - 1. Engineered Air Balance
 - 2. Precision Air

1.05 SERVICES OF THE MECHANICAL CONTRACTOR

- A. Contractor shall provide all volume dampers, balancing dampers, balancing valves, test ports and Pete's plugs as required by the Testing and Balancing Firm.
- B. Contractor shall furnish a set of sheet metal shop drawings and HVAC piping drawings to the Testing and Balancing Firm during the submittal phase and incorporate the Testing and Balancing Firm's mark-ups and requests into the project.
- C. Contractor shall provide all required equipment to facilitate Testing and Balancing Firm's work. This coordination shall be included in the Contractor's base bid price.
- D. Provide, correct, repair or replace deficient items or conditions found during the testing and balancing.
- E. Provide replacement sheaves as directed by TAB Contractor to achieve scheduled air volumes.
- F. For motors with a variable frequency drive, contractor shall provide belt and sheave adjustment such that units deliver their design CFM when speed drive is at 60 hertz.
- G. Verify systems are complete and operable before commencing work. Verify the following:
 - 1. Systems are started and operating in 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. Hydronic systems are flushed, filled, and vented.
13. Pumps are rotating correctly.
14. Proper strainer baskets are clean and in place or in normal position.
15. Service and balancing valves are open.
16. 1Re-sheave

1.06 REPORTS

- A. The TAB firm shall, as a requirement of the TAB contract, arrange with the Architect to compile one set of mechanical specifications, all pertinent change orders, and the following:
 1. One complete set of Drawings less the structural sheets.
 2. One set of mechanical floor plans of the conditioned spaces. These Drawings shall be hard copy and PDF type to facilitate marking.
- B. Approved submittal data on equipment installed, and related changes as required to accomplish the test procedures outlined in Paragraphs 1.06 through 1.10 of this Specification will be available through the Construction Inspector.
- C. Submit test report forms for review a minimum of 30 days prior to requesting a final review by the Architect/ Engineer.
- D. Furnish six (6) individually bound copies of test data. Neatly type and arrange data. Include with the data the date tested, personnel present, weather conditions, nameplate record of test instrument and list all measurements take, both prior to and after any corrections are made to the system. Record all failures and corrective action taken to remedy incorrect situation.
- E. The Architect will retain on (1) copy and the Engineer will retain one (1) copy. The remaining four (4) copies will be returned to the Contractor for inclusion in the operation and maintenance manuals. Refer to Division 01 – Closeout Submittals.

1.07 REFERENCES

- A. AABC. 1989. National Standards for Total System Balance, 5th edition.
- B. AABC. 1997. Testing and Balancing Procedures.
- C. ASHRAE – 1999 Applications Handbook: Chapter 36 – Testing, Adjusting and Balancing.
- D. ASHRAE – 1999 Applications Handbook: Chapter 41 – Building Commissioning.
- E. ASHRAE – 1999 HVAC Application Handbook: Chapter 46, Sound and Vibration Control.

1.08 RESPONSIBILITIES OF THE TAB FIRM

- A. The TAB personnel shall check, adjust, and balance the components of the air conditioning system which will result in optimal noise, temperature, and airflow conditions in the conditioned spaces of the building while the equipment of the system is operating economically. This is intended to be accomplished after the system components are installed and operating as provided for in the contract documents. It is the responsibility of the Mechanical Contractor to

place the equipment into service. Variable air volume systems shall be balanced in accordance with AABC 1989 Standard, Fifth Edition.

B. Liaison and Early Inspection:

1. The TAB firm personnel shall support on the job the commissioning authority responsible to act as liaison between the Owner, Architect and Contractor. The following reviews (observations) and tests shall be performed by the TAB Agency:
 - a. During the design stage, before the documents are finalized, review the mechanical drawings and specifications for balance ability and provide commentary.
 - b. During construction, review all HVAC submittals such as control diagrams, air handling devices, etc., that pertain to commissioning work and balance ability.
 - c. Allow for a fixed number of trips to the project site, over and above those required for testing and balancing for inspection of installation of the mechanical piping systems, sheet metal work, temperature controls and other component parts of the heating, air conditioning and ventilating systems during the construction stage. These inspections shall be made prior to and/or at the above ceiling inspection. Commentary will be provided to the RCM of each observation.
 - d. Test one (1) 8" single duct terminal box for performance capability and leakage as described in Section 23 36 00. The shipment of the box to the TAB Agency's lab will be at the manufacturer's cost and the test period will be for three (3) weeks from receipt of the box. Submittal data will not be approved until box testing passes. If the sample box is rejected for any reason the second test will be at the Contractor's cost and the time allowed will restart when the box is received at the TAB Agency.
 - e. Test one (1) 8" dual duct box for performance capability and leakage as described in Section 23 36 00. The shipment of the box to the TAB Agency's lab will be at the manufacturer's cost and the test period will be for three (3) weeks from receipt of the box. Submittal data will not be approved until box testing passes. If the sample box is rejected for any reason the second test will be at the Contractor's cost and the time allowed will restart when the box is received by the TAB agency.
 - f. Test 10% of the single and dual duct boxes for casing and damper leakage when the shipment arrives at the project site. All testing (except for the initial boxes) shall be performed on site. Boxes requiring re-testing will be charged to the Contractor at the unit price provided to the Owner.
 - g. Test one (1) lab configuration including fume hood with air valve, general exhaust air with air valve and supply air with air valve for performance capability through a full range of inlet pressures. The tracking capability of the exhaust air versus the supply air will be with the submitted hood sash fully open and as the sash is closed in 2" increments until fully closed. Track the three (3) valves' response time in relation to sash movement and the lab differential.
 - 1) During the balancing process, as abnormalities and malfunctions of equipment or components are discovered by the TAB personnel, the Construction Inspector shall be advised in writing so that the condition can be corrected by the Mechanical Contractor. The written document need not be formal, but must be understandable and legible. Data from malfunctioning equipment shall not be recorded in the final TAB report. The TAB firm shall not instruct or direct the Contractor in any of the work, but will make such reports as are necessary to the Owner.

1.09 VABRIATION TESTS

- A. Location of Points for Air Handling Unit Fans and all other Fans:
1. Fan bearing, drive end.
 2. Fan bearing, opposite end.
 3. Motor bearing, center (if applicable)

4. Motor bearing, drive end.
5. Motor bearing, opposite end.
- B. Test Readings.
 1. Horizontal, velocity and displacement.
 2. Vertical, velocity and displacement.
 3. Azial, velocity and displacement.
- C. Normally acceptable readings, velocity and acceleration.
- D. Unusual conditions at time of test.
- E. Vibration sources (if non-complying)

1.10 FINAL AIR BALANCE

- A. General: When systems are complete and ready for operation, the TAB Consultant will perform a final air balance for all air systems and record the results. The outside, supply, exhaust and return air volume for each air handling unit, supply fan and exhaust fan and the supply, exhaust or return air volume for each distribution device shall be adjusted to within +5% of the value shown on the drawings. Air handling unit and fan volumes shall be adjusted by changing fan speed and adjusting volume dampers associated with the unit. Air distribution device volume shall be adjusted using the spin-in tap damper for flexible duct connected devices and the device OBD for duct connected devices. Air distribution devices shall be balanced with air patterns as specified. Duct volume dampers shall be adjusted to provide air volume to branch ducts where such dampers are shown. The general scope of balancing by the TAB Consultant will include, but is not limited to, the following:
 1. Filters: Check air filters and filter media and balance only system with essentially clean filters and filter media. The Division 23 Contractor shall install new filters and filter media prior to the final air balance.
 2. Blower Speed: Measure RPM at each fan or blower to design requirements. Where a speed adjustment is required, the Division 23 Contractor shall make any required changes.
 3. Ampere Readings: Measure and record full load amperes for motors.
 4. Static Pressure: Static pressure gains or losses shall be measured across each supply fan, cooling coil, heating coil, return air fan, air handling unit filter and exhaust fan. These readings shall be measured and recorded for this report at the furthest air device or terminal unit from the air handler supplying that device. Static pressure readings shall also be provided for systems which do not perform as designed.
 5. Equipment Air Flow: Adjust and record exhaust, return, outside and supply air CFM (s) and temperatures, as applicable, at each fan, blower and coil.
 6. Coil Temperatures: Set controls for full cooling and for full heating loads. Read and record entering and leaving dry bulb and wet bulb temperatures (cooling only) at each cooling coil, heating coil and HVAC terminal unit. At the time of reading record water flow and entering and leaving water temperatures (In variable flow systems adjust the water flow to design for all the above readings).
 7. Zone Air Flow: Adjust each zone of multizone units, each HVAC terminal unit and air handling unit for design CFM.
 8. Outlet Air Flow: Adjust each exhaust inlet and supply diffuser, register and grille to within +5% of design air CFM. Include all terminal points of air supply and all points of exhaust. Note: For Labs and Rooms that are negative exhaust air flow shall be set to design +10% and supply to design -5%. Positive areas will have opposite tolerances.
 9. Pitot Tube Traverses: For use in future troubleshooting by maintenance personnel, all exhaust ducts, main supply ducts and return ducts shall have air velocity and volume measured and recorded by the traverse method. Locations of these traverse test stations shall be described on the sheet containing the data.

10. Maximum and minimum air flow on terminal boxes.

1.11 SOUND VIBRATION AND ALIGNMENT

- A. Sound: Read and record sound levels at up to 15 locations in the building designated by the Engineer. All measurements shall be made using an Octave Band Analyzer. All tests shall be conducted when the building is quiet in the presence of the Engineer, if he so desires.
- B. Vibration: Read and record vibration for all water circulating pumps, air handling units, and fans which have motors larger than 10 HP. Include equipment vibration, bearing housing vibration, foundation vibration, building structure vibration, and other tests as directed by the Engineer. Readings will be made using portable IRD (or approved equal) equipment capable of filtering out various unwanted frequencies and standard reporting forms. Maximum vibration at any point listed above, or specified, shall not exceed 1 mil (0.0254 mm) on fans and 1 mil on pumps unless otherwise specified. Equipment manufacturers shall rectify all systems exceeding vibration tolerances.

1.12 TESTING OF TEMPERATURE CONTROL SYSTEMS

- A. In the process of performing the TAB work, the TAB Agency shall:
 1. Work with the temperature control contractor to ensure the most effective total system operation within the design limitations, and to obtain mutual understanding of intended control performance.
 2. Verify that all control devices are properly connected.
 3. Verify that all dampers, valves and other controlled devices are operated by the intended controller.
 4. Verify that all dampers and valves are in the position indicated by the controller (open, closed or modulating).
 5. Verify the integrity of valves and dampers in terms of tightness of close-off and full-open positions. This includes dampers in multizone units, terminal boxes and fire/smoke dampers.
 6. Observe that all valves are properly installed in the piping system in relation to direction of flow and location.
 7. Observe the calibration of all controllers.
 8. Verify the proper application of all normally opened and normally closed valves.
 9. Observe the locations of all thermostats and humidistats for potential erratic operation from outside influences such as sunlight, drafts or cold walls.
 10. Observe the locations of all sensors to determine whether their position will allow them to sense only the intended temperatures or pressures of the media. Control Contractor will relocate as deemed necessary by the TAB Agency.
 11. Verify that the sequence of operation for any control mode is in accordance with approved shop drawings and specifications. Verify that no simultaneous heating and cooling occurs.
 12. Verify that all controller setpoints meet the design intent.
 13. Check all dampers for free travel.
 14. Verify the operation of all interlock systems.
 15. Perform variable volume system verification to assure the system and its components track with changes from full flow to minimum flow.
- B. A systematic listing of the above testing and verification shall be included in the final TAB report.

1.13 SUBMITTALS

- A. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:
 1. Recycled Content:

- a. Indicate recycled content; indicate percentage of pre-consumer and post-consumer recycled content per unit of product.
2. Local/Regional Materials:
 - a. Indicate location of manufacturing facility; indicate distance between manufacturing facility and the project site.
 - b. Indicate location of extraction, harvesting, and recovery; indicate distance between extraction, harvesting, and recovery and the project site.
3. VOC data:
 - a. Submit manufacturer's product data for joint compounds. Indicate VOC and chemical component limits of the product. Submit MSDS highlighting VOC and chemical component limits. VOC contents and chemical component limits must be less than the limits of Green Seal's Standard GS-11.
 - b. Submit manufacturer's certification that products comply with Green Seal's Standard GS-11
 - c. Submit environmental data in accordance with Table 1 of ASTM E2129 for products provided under work of this Section.
4. Submit the following according to Conditions of the Construction Contract.
 - a. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:
5. General: Submit additional LEED submittal requirements included in other sections of the Specifications.
6. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.

PART 2 PRODUCTS

PART 3 EXECUTION

3.01 PREPARATION

- A. Follow industry standard practices and procedures for testing, balancing, as listed in paragraph 1.3 above.
- B. The A/E must be notified a minimum of 72 hours prior to any tests being conducted.
- C. The TAB Contractor must be notified a minimum of five working days prior to conduction any duct leakage tests and same must be present to witness all duct leakage tests.

3.02 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Adjust air handling and distribution systems to obtain required or design supply, return, and exhaust air quantities.
- B. Make air quantity measurements in main 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.
- E. Use volume control devices to regulate air quantities only to extent adjustments do not create objectionable air motion or sound levels. Effect volume control by using volume dampers located in ducts.
- F. Vary total system air quantities by adjustment of fan speeds. Provide sheave drive changes to vary fan speed. 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 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.
- K. Measure building static pressure and adjust supply, return, and exhaust air systems to obtain required relationship between each to maintain approximately 0.05 inches (1.27 mm) positive static pressure near building entries in clean rooms.

3.03 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 - 1. Measure total airflow.
 - a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.
 - b. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
 - c. Measure static pressure directly at the fan outlet or through the flexible connection.
 - d. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
 - e. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
 - 2. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
 - a. Report the cleanliness status of filters and the time static pressures are measured.
 - b. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
 - c. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
 - d. Obtain approval from construction manager for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
 - e. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, sub-main ducts, and major branch ducts to indicated airflows within specified tolerances.
 - 1. Measure airflow of sub-main and branch ducts.
 - 2. Where sufficient space in sub-main and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
 - 3. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
 - 4. Re-measure each sub-main and branch duct after all have been adjusted. Continue to adjust sub-main and branch ducts to indicated airflows within specified tolerances.

5. Measure air outlets and inlets without making adjustments.
- C. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.
 1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
 2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.04 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

- A. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at minimum set-point airflow with the remainder at maximum-airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.
- B. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
 1. Set outdoor-air dampers at minimum, and set return- and exhaust-air dampers at a position that simulates full-cooling load.
 2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
 3. Measure total system airflow. Adjust to within indicated airflow.
 4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
 5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.
 6. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.
 7. Re-measure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
 8. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.
 9. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.
 10. Record final fan-performance data.

3.05 MECHANICAL EQUIPMENT

- A. Verify the following:
 1. Equipment is operable and in 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. Correct fan rotation.

7. Fire and volume dampers are in place and open.
8. Coil fins have been cleaned and combed.
9. Access doors are closed and duct end caps are in place.
10. Air outlets are installed and operable.
11. Duct system leakage has been minimized.
12. Pretest components in the VFD. Provide factory certification of testing the entire VFD with varying induction motor loads for 24 hours prior to shipment.
13. Proper sequencing and operation of all DDC Control System components and equipment as required by ASHRAE Standard on Total Building Mechanical System operation.
14. Perform sound power level tests and provide required data on each occupied space adjacent to, above, or below mechanical/ air handling unit equipment rooms.
15. Perform vibration test and provide required data on each piece of air handling/ ventilation equipment or fan. Vibration testing must be complete in compliance with the requirements of ASHRAE – 1999 HVAC applications Handbook Chapter 46, Sound and Vibration Control and the maximum listed RMS values listed herein.

B. Duct Leakage

1. Test all supply air ductwork, to include, but not limited to, downstream of all single zone and multi-zone air handling units, downstream of all VAV air handling units and upstream of fan powered terminal units at 2-1/2 inches (64 mm) of static pressure (except where this requirement would exceed the ductwork design pressure classification) to have a total leakage value not to exceed 2% of the total system airflow.
2. Test all supply, return, and exhaust air ductwork, to include, but not limited to, downstream of fan coil units and fan powered terminal units, upstream of air handling units, and upstream and downstream (where applicable) of fans at 1-1/2 inches (38 mm) of static pressure to have a total leakage value not to exceed 2% of the total system design airflow.
3. Ductwork that initially fails these tests shall be replaced, modified, resealed, etc. as required to meet the leakage requirement and then re-tested to ensure compliances.

3.06 REPORTS

- A. The activities described in this section shall culminate in a report to be provided in quadruplicate (4) individually bound to the RCM. Neatly type and arrange data. Include with the data the date tested, personnel present, weather conditions, nameplate record of test instrument and list all measurements taken after all corrections are made to the system. Record all failures and corrective action taken to remedy incorrect situation. The intent of the final report is to provide a reference of actual operating conditions for the Owner's operations personnel.
- B. All measurements and recorded readings (of air, electricity, etc.) that appear in the reports must have been made onsite by the permanently employed technicians or engineers of the firm.
- C. At the option of the Construction Inspector, all data sheets tabulated each day by TAB personnel shall be submitted for initial by the Construction Inspector. Those work sheets so initialed, or copies thereof, shall be presented as a supplement to the final TAB report.
- D. Submit reports on forms approved by the Owner & Engineer which will include the following information as a minimum:
 1. Title Page
 - a. Company Name
 - b. Company Address
 - c. Company telephone number
 - d. Project name
 - e. Project location
 - f. Project Manager

- g. Project Engineer
- h. Project Contractor
- i. Project Identification Number
- 2. Instrument List
 - a. Instrument
 - b. Manufacturer
 - c. Model
 - d. Serial Number
 - e. Range
 - f. Calibration date
 - g. What test instrument was used for
- 3. Fan Data (Supply and Exhaust)
 - a. Location
 - b. Manufacturer
 - c. Model
 - d. Air flow, specified and actual
 - e. Total static pressure (total external), specified and actual
 - f. Inlet pressure
 - g. Discharge pressure
 - h. Fan RPM
- 4. Return Air/Outside Air Data (If fans are used, same data as for 3 above)
 - a. Identification/location
 - b. Design return air flow
 - c. Actual return air flow
 - d. Design outside air flow
 - e. Return air temperature
 - f. Outside air temperature
 - g. Required mixed air temperature
 - h. Actual mixed air temperature
- 5. Electric Motors
 - a. Manufacturer
 - b. HP/BHP
 - c. Phase, voltage, amperage, nameplate, actual
 - d. RPM
 - e. Service factor
 - f. Starter size, heater elements, rating
- 6. V-Belt Drive
 - a. Identification/location
 - b. Required driven RPM
 - c. Driven sheave, diameter and RPM
 - d. Belt, size and quantity
 - e. Motor sheave, diameter and RPM
 - f. Center-to-center distance, maximum, minimum and actual
- 7. Duct Traverse
 - a. System zone/branch
 - b. Duct size
 - c. Area
 - d. Design velocity
 - e. Design air flow
 - f. Test velocity

- g. Test air flow
 - h. Duct static pressure
 - i. Air temperature
 - j. Air correction factor
- 8. Air Monitoring Station Data
 - a. Identification/location
 - b. System
 - c. Size
 - d. Area
 - e. Design velocity
 - f. Design air flow
 - g. Test velocity
 - h. Test air flow
- 9. Air Distribution Test Sheet
 - a. Air terminal number
 - b. Room number/location
 - c. Terminal type
 - d. Terminal size
 - e. Area factor
 - f. Design velocity
 - g. Design air flow
 - h. Test (final) velocity
 - i. Test (final) air flow
- 10. Cooling Coil Data
 - a. Identification/number
 - b. Location
 - c. Service
 - d. Manufacturer
 - e. Entering air DB temperature, design and actual
 - f. Entering air WB temperature, design and actual
 - g. Leaving air DB temperature, design and actual
 - h. Leaving air WB temperature, design and actual
 - i. Air pressure drop, design and actual
- 11. Heating Coil Data
 - a. Identification/number
 - b. Location
 - c. Service
 - d. Manufacturer
 - e. Air flow, design and actual
 - f. Entering air temperature, design and actual
 - g. Leaving air temperature, design and actual
 - h. Air pressure drop, design and actual
- 12. Sound Level Report
 - a. Location (Location established by the design engineer)
 - b. NC curve for eight (8) bands - equipment off
 - c. NC curve for eight (8) bands - equipment on
- 13. Vibration Test on equipment having 10 HP motors or above
 - a. Location of points:
 - 1) Fan bearing, drive end
 - 2) Fan bearing, opposite end

- 3) Motor bearing, center (if applicable)
- 4) Motor bearing, drive end
- 5) Motor bearing, opposite end
- 6) Casing (bottom or top)
- 7) Casing (side)
- 8) Duct after flexible connection (discharge)
- 9) Duct after flexible connection (suction)
- b. Test readings:
 - 1) Horizontal, velocity and displacement
 - 2) Vertical, velocity and displacement
 - 3) Axial, velocity and displacement
- c. Normally acceptable readings, velocity and acceleration
- d. Unusual conditions at time of test
- e. Vibration source (if non-complying)
- 14. Control verification indicating date performed and any abnormalities identified.
 - a. Point Location/Description
 - b. EMS Readout (Setpoint and Actual)
 - c. Actual Readout
 - d. Interlocks
 - e. Safeties
 - 1) VSD Normal Operation
 - 2) VSD Bypass Operation
 - f. Alarms
 - g. Sequences of Operation

END OF SECTION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Retain or delete this article in all Sections of Project Manual.
- B. Furnish and install thermal insulation for mechanical and plumbing piping systems including jackets and accessories.
- C. Insulation systems for sheet metal duct conveying cold, hot and grease laden air. Provide duct insulation systems which have been manufactured, fabricated and installed to meet all thermal requirements of mechanical systems. Insulating systems shall be installed in strict accordance with manufacturer's field requirements and the current International Energy Conservation Code.
- D. HVAC system includes horizontal roof drain, lines, and waste lines which receive condensate from air handling units or evaporators.

1.02 REFERENCE STANDARDS

- A. 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).
- B. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement; 2007 (Reapproved 2024).
- C. ASTM C240 - Standard Test Methods for Testing Cellular Glass Insulation Block; 2021.
- D. ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation; 2017 (Reapproved 2023).
- E. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation; 2025.
- F. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications; 2024.
- G. ASTM C591 - Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation; 2022.
- H. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation; 2025.
- I. ASTM C739 - Standard Specification for Cellulosic Fiber Loose-Fill Thermal Insulation; 2025.
- J. ASTM C1126 - Standard Specification for Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation; 2024.
- K. ASTM C1338 - Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings; 2025.
- L. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026a.
- M. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.03 RELATED SECTIONS

- A. Section 090190 – Maintenance of Painting and Coatings.
- B. Section 230529 – Hangers and Supports for HVAC Piping and Equipment.
- C. Section 230553 – Mechanical Identification
- D. Section 013300 Submittals.
- E. Section 01524 Construction Waste Management

1.04 REFERENCES

- A. ASTM C 178 – Steady State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-HOT-Plate Apparatus.
- B. ASTM C195 – Mineral Fiber Thermal Insulation Cement.
- C. ASTM C533 – Calcium Silicate Block and Pipe Thermal Insulation.
- D. ASTM C 534 - Preformed Flexible Elastomeric Cellular Thermal Insulation.
- E. ASTM C547 – Mineral Fiber Preformed Pipe Insulation.
- F. ASTM C591 – Preformed Cellular Polyurethane Thermal Insulation.
- G. ASTM C1126 – Rigid Cellular Phenolic Thermal Insulation.
- H. ASTM B 209 – Aluminum and Aluminum-alloy Sheet and Plate.
- I. ASTM E84 – Surface Burning Characteristics of Building Materials.
- J. ASTM E 96 –Water Vapor Transmission of Materials.

1.05 SUBMITTALS

- A. Include product description, list of materials, and thickness for each service and locations.
- B. Include detail drawings of insulation dams.

1.06 QUALITY ASSURANCE

- A. Application Company Qualifications: The installing company must be solely and exclusively in the business of insulation installation for the previous consecutive five year period. The installing company must also be regularly engaged in installing the specific specified insulation material types on projects of equal or greater magnitude and scope as this project for the previous consecutive five year period. Documentation of the above listed requirements must be submitted prior to insulation material submitted.
- B. Application Personnel Qualifications: The installing company must provide qualified installation personnel on this project jobsite directly employed by them who are skilled and proficient at installing the specific specified insulation Material types.
- C. Any material found, by the A/E, to be improperly installed or not installed in total compliance with the specific installation instructions and methods (written or implied) of the material manufacturer must be removed by the installing company. The preparation instructions must be followed prior to the re-installation of the insulation material using the correct installation instructions and methods of the material manufacturer.
- D. All material (to include, but not limited to, insulation, jackets, facings, coatings, mastics, adhesive, sealants, etc.) Installed inside the building must have a certified and tested composite flame spread/smoke developed rating of 25/50 inch (12.7 mm) accordance with ASTM E84.

1.07 ENVIRONMENTAL REQUIREMENTS

- A. Maintain ambient temperatures and conditions required by manufacturers of adhesive and insulation.
- B. All insulation shall comply with IECC 2012.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Insulation
 - 1. Owens-Corning Fiberglass Corporation.
 - 2. UpJohn CRP/DOW Chemical Company.
 - 3. Knuff Corporation.

4. FGH Fabricators, Inc.
 5. Armstrong.
 6. Quiet Liner by Acoustical Surfaces Inc.
- B. Jackets
1. Childers Products Company.
 2. PABCO.
 3. RFR Products, Inc.
 4. Kinetics Duct Wrap

2.02 PIPE INSULATION

- A. Type B-1: Elastomer, closed cell, flexible, insulation; ASTM E 96, maximum vapor transmission rating of 0.20 pers; ASTM C177; 'k' value of 0.27 at 75 degrees Fahrenheit (23.89 degrees Celsius).
- B. Type B-2: Fiberglass Piping Insulation: ASTM C547, Class 1 unless otherwise indicated. (Indoor locations only).

2.03 DUCT INSULATION MATERIALS

- A. Type C: Flexible Fiberglass Duct Insulation (Indoor application): ASTM C553, Type I, Class B-4, 2" thick, 1.0 PCF density, minimum R-6 (installed) with foil faced continuous vapor barrier. This application is limited to concealed indoor locations only.
- B. Type D: Rigid Fiberglass Duct Insulation (Indoor application): ASTM C612, Class 1, 2" thick, 3.0 PCF densities, for both supply and exhaust round ducts exposed to view locations, or spaces without ceilings. Round duct insulation shall be E. O. Wood Rigid wrap® for all round ducts in areas without ceiling.
- C. Type E: Rigid Foam Glass Duct Insulation (Outdoor application): Foamglas ONETM block with 7.3 lbs/ft³ and 0.29 (0.29)-inch /hr F thermal conductivity per ASTM C240, Type I.
- D. Type F: Quiet Liner by Acoustical Surfaces Inc. or approved equal. Quiet Natural Fiber Liner shall be thermally bonded HVAC insulation with superior acoustic and thermal performance. Liner shall be made from natural fibers; Quiet Liner™ shall not contain fiberglass. The fibers used to manufacture Quiet Liner shall offer sound absorption properties. The air stream surface shall be overlaid with a durable, fire-resistant black facing, to provide additional strength to the product. Both the insulation and the facing shall be treated with an EPA registered anti-microbial agent. Surface Burning Characteristics shall be less than 25/50 shall be Class A / Class 1 per ASTM E84, UL 723, and NFPA 255. Fungi Resistance shall indicate no growth per ASTM C1338 and ASTM C739. Water Vapor Absorption shall be less than 1% by weight per ASTM C1104.
- E. Jackets for Duct Insulation: ASTM C 921, Type I for duct with temperatures below ambient; Type II for duct with temperatures above ambient.
- F. Jackets for outdoor Duct Insulation: Encase exterior duct insulation with 16 MIL Stainless steel jacket with "Z" closures for weather-proof construction.
- G. Duct Insulation Accessories: Provide bands, wires, tape, anchors, corner angles and similar accessories as recommended by insulation manufacturer for applications indicated.
- H. Mechanical Fasteners:
1. Gemco Type IH-A from Goodloe E. Moore, Inc., Danville, IL 800-331-1164.
 2. Eckoustic-Klip from Eckel Industries Inc., Cambridge, MA 617-491-3221.
 3. INC Stick-Pin from Industrial Noise Control Inc. Addison, IL 312-620-1998.
- I. Duct Insulation Compounds: Provide cements, adhesives, coatings, sealers, protective finishes and similar compounds as recommended by insulation manufacturer for applications indicated.
1. 15-141 from King Co., St. Louis, MO 314-772-9953.

2. Tuffbond from Goodloe E. Moore, Inc., Danville, IL 800-331-1164.
 3. INC C-700 from Industrial Noise Control Inc., Addison, IL 312-620-1998.
- J. All external duct wrap shall be 2 " thick, 1.0 P.C.F. density minimum, and is required on all and supply air duct that also meets with the minimum R-value per International Energy Code 2013. External duct wrap shall be with foil faced continuous vapor barrier. This application is limited to concealed indoor locations only.

2.04 DUCTWORK JACKETS

- A. Interior, Concealed Applications
1. Type D Insulation: one and a half (1½") pounds per cubic feet minimum density semi-rigid glass fiber. Provide factory applied ASJ white kraft foil vapor barrier. Type B Insulation: Finish coat is not required.
 2. Insulate fittings, joints and valves with molded insulation of like material and thickness as adjoining pipe. Use insulating cement to fill voids and cracks. Finish with #10 glass membrane and Childers #CP-30 L.O. vapor barrier mastic.
- B. Interior, Exposed Applications
1. Double wall duct and fittings will consist of a solid inner liner, 1" thick x 1.0 lb/ft3 layer of glass fiber insulation, and a solid outer pressure shell.
 2. Double wall jacket with spiral lockseam with standing rib.
 3. Fitting ends shall be sized to slip-fit into spiral duct of the same nominal size.
- C. Exterior Applications
1. Prime sheet metal with Pittcote 300 before the installation of insulation.
 2. Insulate exterior ductwork with 2 layers of 1 ½" thick FOAMGLAS sheet.
 3. Wrap insulation with 8 oz canvas. Finish with 2 coats on 8 oz canvas shall be Childers CP-50 prior to final jacket installation.
 4. Cover with 0.02 inch (0.51 mm) thick stainless steel jacket having integral moisture barrier with seams located at 2 or 10 o'clock position of horizontal piping. All laps must be minimum 2".
- D. Jacket Materials
1. Factory Applied Jackets: White kraft bonded to reinforced foil vapor barrier with self-sealing adhesive joints.
 2. PVC Jackets: One piece, pre-molded type, to meet flame spread and smoke developed rating of 25/50 inch (12.7 mm) accordance with ASTM E84.
 3. Canvas Jackets: UL listed treated cotton fabric, 8 ounces per square
 4. Fiberglass Cloth Reinforcing Mesh: #10 glass cloth with minimum weight of 3.9 ounces per square yard.
 5. Aluminum Jackets: (Indoor applications exposed to view) ASTM B 209, 0.020 inch (0.51 mm) thick; smooth finish with factory applied moisture barrier.
 6. Stainless Steel Jackets: (Outdoor applications) Type 304 stainless steel; 0.010 inch (0.25 mm) thick; smooth finish.

2.05 ACCOUSTICAL DUCT WRAP (TYPE L)

- A. The sound control lagging material is applied continuously as part of the duct system to reduce sound transmission from the duct i.e., control breakout noise.
- B. Material shall consist of a rugged, reinforced aluminized-faced, mass loaded limp vinyl barrier, 9.8-kg/m2 (2-psf). Material shall be non-lead composition for safe handling and easy installation.
- C. Pipe and duct shall be wrapped with fiber glass batt or other appropriate resilient material in order to decouple sound control lagging from surface of pipe and duct. For the required optimal performance, sound control lagging shall be installed / wrapped over the duct thermal insulation and shall not be applied directly to surface of duct.

- D. The sound control lagging material shall be provided by a manufacturer having a minimum of five years' experience in furnishing similar noise control lagging material for pipe and duct.
- E. The barrier shall be constructed of a 6-mm (0.24") thick mass loaded, limp vinyl sheet bonded to a thin layer of reinforced aluminum foil on one side. The barrier shall have a nominal density of 9.8-kg/m² (2.0-psf).
- F. Sound control lagging material shall be Kinetics Noise Control, Inc. Model KNM-200AL or equal.
- G. Products not meeting minimum test standards will not be accepted. Submittals shall include test reports from independent laboratories meeting the following minimum criteria:
- H. Insertion Loss when tested as a duct wrap over 51-mm (2") thick, 80.1 kg/m (5-pcf) fiber glass over a 20-gauge duct system (per ASTM E1222-90)

FREQUENCY, HZ	63	125	250	500	1000	2000	4000
	5	9	18	28	34	37	37

2.01 ACCESORIES

- A. A. Insulation Bands: 3/4 inch (19.05 mm) wide; 0.015 inch (0.38 mm) thick galvanized steel, stainless steel or 0.007 inch (0.18 mm) thick aluminum.
- B. Metal Jacket Bands: 3/8 inch (9.52 mm) wide; 0.015 inch (0.38 mm) thick aluminum or 0.010 inch (0.25 mm) thick stainless steel to match jacket.
- C. Insulating Cement: ASTM C195; hydraulic setting mineral wool; Ryder One-Coat.
- D. Sealants: Used at valve, fittings and where insulation is terminated. Brushes apply sealant to end of insulation and continued along pipe surface. Provide Childers CP-30 L.O. sealant.
- E. Adhesives: Used to adhere the longitudinal lap seam of vapor barrier jackets and at butt joints between insulation or fitting covers. Provide Childers CP-82 or approved equal as general purpose adhesive. Use Childers CP-97 fibrous adhesive for calcium silicate or when adhering pipe saddles and shields to the insulation.
- F. Primers: Provide Childers CP-50 diluted 50% with water primer to cover insulating cements prior to finish coating.

PART 3 EXECUTION

3.01 PIPE PREPARATION

- A. Thoroughly clean all surfaces to be insulated as required to remove all oil, grease, loose scale, rust, and foreign matter. Piping must be completely dry at the time of application.
- B. The installation of piping insulation associated with an operating chilled water system is strictly prohibited.
- C. Provide primer coat on all piping, to include field welds and over factory applied paint/ coating, in total compliance and compatible with and approved by the Engineer prior to installation of insulation (No Exceptions).
- D. Install insulation material only after all performance tests on piping have been completed and approved by the Engineer (No Exceptions).

3.02 PIPE INSULATION INSTALLATION

- A. Install materials in complete and total compliance with the specific manufacturer's installation instructions.
- B. Continue vapor barrier through wall and floor penetrations.
- C. In exposed piping, locate insulation and cover seams in least visible locations.

- D. Insulate fittings, valves, flanges and strainers. On flexible connections, expansion joints and unions, bevel and seal ends of insulation and continue sealant a minimum of 4 inches (101.6 mm) along the piping.
- E. Provide dams in insulation at intervals not to exceed 20 feet (609.6 cm) to prevent migration of condensation or leakage.
- F. Provide an insert of same thickness and contour as adjoining insulation, between support shield and piping, and under the finish jacket, on piping 2 1/2 inch (12.7 mm) diameter or larger, to prevent insulation from sagging at support points. Provide inserts for 180-degree arc and not less than the length of the pipe support shield or minimum 12 inches (304.8 mm) long (whichever is greater) manufactured of 5.0# density cellular phenolic insulation material suitable for the planned temperature range. Factory fabricated inserts with integral galvanized pipe saddles are recommended. Adhere pipe support shield to insulation with adhesive.
- G. Neatly finish and seal insulation at supports, protrusions and interruptions. Maintain vapor barrier with finish coat.
- H. Paint exposed pipe insulation in total compliance with Section 210553 and Section 090190.

3.03 DUCT SYSTEM INSULATION

- A. Insulate all supply, return fresh-air, outside-air, make-up air and exhaust ducts.
- B. Cold Ducts: Temperatures below the space dew point shall have the insulation vapor barrier be continuous and unbroken through inside walls, sleeves and floor openings. Where connection is made to fire or fire/smoke damper in wall or floor the vapor barrier must extend to the wall or floor to prevent ambient air water vapor from condensing on the cold surfaces of the fire damper.
- C. Duct Wrap: Fasten all longitudinal and circumferential laps with outward clinching staples 3" on center. On rectangular ducts over 24" wide, apply as above and hold insulation in place on bottom side with mechanical pins and clips on 12" centers.
- D. Duct Wrap: Seal all joints, fastener penetrations and other breaks in vapor barrier with 3-inch-wide strips of white glass fabric embedded between two coats of vapor barrier mastic, Childers CP-30 or approved equal.
- E. Cold Duct (Below Ambient Temperature):
 - 1. Application Requirements: Insulate the following cold duct:
 - a. Outdoor air intake duct between air entrance and fan inlet or HVAC unit inlet.
 - b. HVAC supply duct between fan discharge, or HVAC unit discharge, and room terminal outlet.
 - 1) Insulate neck, backside, and bells of supply diffusers.
 - c. HVAC return duct between room terminal inlet and return fan inlet, or HVAC unit inlet.
 - d. HVAC plenums and unit housings not pre-insulated at factory or lined.
 - e. Exhaust duct work within the building non air-conditioned spaces.
 - 2. Insulate each duct system specified above with one of the following types and thicknesses of insulation:
 - a. Rigid Fiberglass: 2" thick, 3.0 PCF density, for both supply and exhaust round ducts exposed outdoor locations, or spaces without ceilings. Round duct insulation shall be E. O. Wood Rigid wrap® for all round ducts in areas without ceiling.
 - b. Flexible Fiberglass: 2" thick, 1.0 PCF density, minimum R-6 with foil faced continuous vapor barrier. This application is limited to concealed indoor locations only.
 - c. Foamglass: two (2) layers of 1" thick insulation blocks or 2" thick Armstrong Type II Armaflex flexible elastomeric closed cell sheet insulation or approved equal. (For outdoors locations).

- d. Exhaust ductwork within the air-conditioned spaces do not require to be insulated.
Exhaust duct on roof exposed to the outside weather do not require to be insulated.

3.04 INSTALLATION

- A. Install materials in accordance with manufacturer's instructions.
- B. Insulated ductwork conveying air below ambient temperature:
 - 1. Provide insulation with vapor barrier jackets.
 - 2. Finish with tape and vapor barrier jacket.
 - 3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
 - 4. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.
- C. Insulated ductwork conveying air above ambient temperature:
 - 1. Provide with or without standard vapor barrier jacket.
 - 2. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.
- D. For ductwork exposed in finished spaces.
 - 1. Double wall duct and fittings will consist of a solid inner liner, 1" thick x 1.0 lb/ft³ layer of glass fiber insulation, and a solid outer pressure shell.
 - 2. Double wall jacket with spiral lockseam with standing rib.
 - 3. Fitting ends shall be sized to slip-fit into spiral duct of the same nominal size.
- E. External / Outdoor Duct Insulation Application:
 - 1. Secure insulation with vapor barrier with wires and seal jacket joints with vapor barrier adhesive to match jacket.
 - 2. Secure insulation without vapor barrier with staples, tape, or wires.
 - 3. Install without sag on underside of ductwork. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift ductwork off trapeze hangers and insert spacers.
 - 4. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.
 - 5. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.
 - 6. Install 0.02" thick smooth Stainless steel jacket on ductwork installed outdoors / on roof.
- F. The sound control lagging material is critical in order to achieve the desired noise reduction. Sound control lagging material shall be cut to length, wrapped around the outside of the duct, and fastened with mechanical fasteners or bands. Tape and adhesive can be used in conjunction with mechanical fasteners or bands. All sound control lagging materials must be installed per the manufacturer's installation guidelines.
- G. Duct and Plenum Liner Application:
 - 1. Adhere insulation with adhesive for 100 percent coverage.
 - 2. Secure insulation with mechanical liner fasteners. Refer to SMACNA Standards for spacing.
 - 3. Seal and smooth joints.
 - 4. Seal liner surface penetrations with adhesive.
 - 5. Duct dimensions indicated are net inside dimensions required for air flow. Increase duct size to allow for insulation thickness.
- H. All piping, equipment, ductwork, all plenums including metal and masonry construction, fans, etc., shall be insulated as indicated on the Drawings, as specified herein, and as required for a complete system. In each case, the insulation shall be equal to that specified and materials applied and finished as described in these Specifications.
- I. All insulation shall be applied by mechanics skilled in this particular work and regularly engaged in such occupation. All insulation shall be applied in strict accordance with these Specifications

and with factory printed recommendations on items not herein mentioned. Unsightly, inadequate, or sloppy work will not be acceptable, and all such work shall be removed and replaced as many times as necessary to achieve an acceptable installation.

- J. All insulation, jacket, adhesives, mastics, sealers, etc., utilized in the fabrication of these systems shall meet NFPA for fire resistant ratings (maximum of 25 flame spread and 50 smoke developed ratings) and shall be approved by the insulation manufacturer for guaranteed performances when incorporated into their insulation system, unless a specific product is specified for a specific application, and is stated as an exception to this requirement. Certificates to this effect shall be submitted along with Contractor's submittal data for this section of the Specifications. No material may be used that, when tested by the ASTM E84-89 test method, is found to melt, drip or delaminate to such a degree that the continuity of the flame front is destroyed, thereby resulting in an artificially low flame spread rating.
- K. All surfaces to be insulated shall be clean and dry before applying the insulation. All sections of molded pipe covering shall be firmly butted together. Where an insulation covering is applied, it shall lap the adjoining section of insulation by at least three inches (3"). Where insulation terminates, it shall be neatly beveled and finished. No insulation shall be applied until the pipe, duct, etc., have been pressure tested and found tight. Piping, flexible connections, flanges, valves, strainers, and unions shall be covered unless specifically noted otherwise. Flexible connections on duct shall not be covered. All materials used shall be fire retardant or nonflammable.
- L. Where vapor barriers are required, the vapor barrier shall be on the outside. Extreme care shall be taken that the vapor barrier is unbroken. Joints, etc., shall all be sealed. Where insulation with a vapor barrier terminates, it shall be sealed off with the vapor barrier being continuous to the surface being insulated. Ends shall not be left raw.
- M. Extreme care shall be taken in covering high and medium pressure (high and medium pressure ductwork shall be all ductwork between the fan discharge and all mixing boxes) ductwork to insure the duct is not pierced with sheet metal screws or other fasteners. All high and medium pressure ducts in these specifications are classified as high velocity ductwork.
- N. Where specified, aluminum bands shall be used on piping insulation. The bands shall be applied three (3) to a section of pipe. Fittings, valves, etc., shall have bands on each side.
- O. For purpose of definition in this Specification: "concealed" areas are those areas which cannot be seen by the building occupants, and "exposed" areas are all areas which are exposed to view by the building occupants, including under counter and inside cabinet areas, plus all mechanical rooms.
- P. Provide 2 hour enclosure on grease exhaust duct. Enclosure shall extend from kitchen hood to underside of roof deck.
- Q. The handling and installation of all insulation materials shall be performed in strict accordance with the manufacturer's recommendations.

3.05 SCHEDULE

Duct or Piping	Type	Duct / Pipe Size	Insulation Thickness
Condensate Drain Lines (Interior Exposed)	B-1	All Sizes	1"
Refrigerant Suction Piping	B-1	2" & Smaller	1 ½ "
Indoor ductwork Insulation	C	All sizes	2" & 1.0 lbs. density

Concealed Spaces			
All ductwork downstream from the VAV terminal units	L	All ducts All sizes	1" thick & 2 lbs. density.
Acoustical ductwork Liner	F	All sizes	2" & 1.5 lbs density
In Transfer Ducts and Return Boots			
Indoor ductwork Insulation			
Non-concealed Spaces	D	All sizes	2" & 3.0 lbs density
Provide Aluminum Jacket			
Outdoor Ductwork Insulation			
Provide 0.020"x 36" smooth Stainless steel Jacket	E	All sizes	two (2) layers of rigid 1" thick, and 7.3 lbs/ft3 density

END OF SECTION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Retain or delete this article in all Sections of Project Manual.
- B. Equipment insulation.
- C. Covering.

1.02 REFERENCE STANDARDS

- A. 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).
- B. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement; 2007 (Reapproved 2024).
- C. ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation; 2017 (Reapproved 2023).
- D. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications; 2024.
- E. ASTM C591 - Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation; 2022.
- F. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation; 2025.
- G. ASTM C1126 - Standard Specification for Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation; 2024.
- H. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026a.
- I. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.03 RELATED SECTIONS

- A. Section 090190 – Maintenance of Painting and Coatings.
- B. Section 232123 – Centrifugal Hydronic Pumps.
- C. Section 230553 – Identification for HVAC Piping and Equipment.
- D. Section 013300 Submittals.
- E. Section 01524 Construction Waste Management

1.04 REFERENCES

- A. First four paragraphs below are defined in Division 01 Section "Submittal Procedures" as "Action Submittals."
- B. ASTM C195 – Mineral Fiber Thermal Insulation Cement.
- C. ASTM C533 – Calcium Silicate Block and Pipe Thermal Insulation.
- D. ASTM C 534 - Preformed Flexible Elastomeric Cellular Thermal Insulation.
- E. ASTM C553 – Mineral Fiber Blanket and Felt Insulation.
- F. ASTM C591 – Preformed Cellular Polyurethane Thermal Insulation.
- G. ASTM C612 – Mineral Fiber Block and Thermal Insulation.
- H. ASTM C1126 – Rigid Cellular Phenolic Thermal Insulation.
- I. ASTM E84 – Surface Burning Characteristics of Building Materials.

J. ASTM 255 – Surface Burning Characteristics of Building Materials.

K. UL 723 – Surface Burning Characteristics of Building Materials.

1.05 SUBMITTALS

A. Include product description, list of materials, and thickness for equipment scheduled.

1.06 QUALITY ASSURANCE

A. Application Company Qualifications: The installing company must be solely and exclusively in the business of insulation installation for the previous consecutive five year period. The installing company must also be regularly engaged in installing the specific specified insulation material types on projects of equal or greater magnitude and scope as this project for the previous consecutive five year period. Documentation of the above listed requirements must be submitted prior to insulation material submitted.

B. Application Personnel Qualifications: The installing company must provide qualified installation personnel on this project jobsite directly employed by them who are skilled and proficient at installing the specific specified insulation Material types.

C. Any material found, by the A/E, to be improperly installed or not installed in total compliance with the specific installation instructions and methods (written or implied) of the material manufacturer must be removed by the installing company. The preparation instructions must be followed prior to the re-installation of the insulation material using the correct installation instructions and methods of the material manufacturer.

D. All material (to include, but not limited to, insulation, jackets, facings, coatings, mastics, adhesive, sealants, etc.) Installed inside the building must have a certified and tested composite flame spread/smoke developed rating of 25/50 inch (12.7 mm) accordance with ASTM E84.

1.07 ENVIRONMENTAL REQUIREMENTS

A. Maintain ambient temperatures and conditions required by manufacturers of adhesive and insulation.

B. Insulation to provide minimum R-Value in accordance with International Energy Conservation Code with Local Municipality Amendment.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Owens-Corning Fiberglass Corporation.

B. UpJohn CPR/ Dow Chemical Company.

C. Manville Corporation.

D. Armstrong.

2.02 INSULATION

A. Type A: Mineral fiber or fiberglass preformed insulation: ASTM C553; 'k' value of 0.24 at 75 degrees Fahrenheit (23.89 degrees Celsius); 2.0 lb/ cu ft. density.

B. Type B: Rigid fiberglass or mineral fiber board; ASTM C612; 'k' value of 0.24 at 75 degrees Fahrenheit (23.89 degrees Celsius); 6.0 lb/ cu ft. density.

C. Type C: Molded closed cell polyisocyanurate insulation; ASTM E96, maximum water vapor transmission rating of 0.005 perm-in; ASTM C177, 'k' value of 0.18 at 75°F; ASTM D2842m water absorption value of 0.05 lb/ft².

D. Type D: Calcium silicate; ASTM C533; asbestos free; 'k' value of 0.40 at 250 degrees Fahrenheit (121.11 degrees Celsius).

- E. Type E: Closed cell, chemically neutral, neoprene insulation, 'k' value of 0.27 at 75 degrees Fahrenheit (23.89 degrees Celsius); sheet form; Armstrong Armaflex.
- F. Type F: Phenolic closed cell, ASTM C1126 rigid foam, 3.5 lbs. Nominal density, CFC free; ASTM C177, 'k' value of 0.18 at 75°F.
- 1. INSULATION METAL JACKET
- G. Provide Metal Jacket outdoors.
- H. Jacket - .016"x 36" aluminum smooth with moisture barrier jacket.
- I. Jacket - .020" x 36" aluminum smooth with moisture barrier jacket (High traffic areas.).
- J. Aluminum fasteners – 3/4" bands, 3/4" wing seals .024 elbow covers.
- K. T-304 stainless steel fasteners – 1/2" x .020 bands, 1/2" wing seals.
- L. Screws are not to be used to secure jacketing.

2.03 ACCESSORIES

- A. Adhesives: Non-shrinking, permanently flexible, compatible with insulation. For general purpose use Childers CP-82 adhesive. For calcium silicate, use Childers CP-97 fibrous adhesive.
- B. Sealants: For general purpose to seal the end of the insulation, use Childers CP-30 L.O. sealant.
- C. Insulating Cement: ASTM C195; hydraulic setting mineral wool; Ryder One-Coat.
- D. Wire Mesh: Corrosive-resistant metal; 1 inch (25.4 mm) hexagonal pattern.
- E. Primers: Use Childers CP-50 diluted 50% with water primer to seal over insulating cements and fibrous adhesives prior to finish coating.
- F. Finish Coats: For general purpose, use Childers CP-30 L.O. reinforce with glass cloth. For calcium silicate, use Childers CP-50 finish coat reinforced with canvas jacket. For finish coat over closed cell electretic, use Childers CP-17 or Armstrong "Finish" acrylic finish.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install materials in accordance with manufacturer's installation instructions.
- B. Do not insulate factory insulated equipment.
- C. Do not insulate boiler or expansion or volume tank manholes, hand holes, cleanouts, ASME stamp, and manufacturer's nameplate. Provide neatly beveled edge at interruptions of insulation. Provide removable insulation sections to cover parts of equipment which must be opened periodically for maintenance; include metal vessel covers, fasteners, flanges, frames and accessories.
- D. Apply insulation as close as possible to equipment by grooving, scoring, and beveling insulation, if necessary. Secure insulation to equipment with studs, pins, clips, adhesive, wires or bands.
- E. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor barrier cement.
- F. Cover insulation with metal mesh and finish with heavy coat of insulating cement.
- G. Do not insulate over nameplate or ASME stamps. Bevel and seal insulation around such.
- H. When equipment with insulation requires periodical opening for maintenance, repair, or cleaning, install insulation in such a manner that it can be easily removed and replaced without damage.

3.02 INSTALLATION

- A. Install materials in accordance with manufacturer's instructions.
- B. Do not insulate factory insulated equipment.
- C. On exposed equipment, locate insulation and cover seams in least visible locations.
- D. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Secure insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
- E. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor barrier cement.
- F. Insulated dual temperature equipment or cold equipment containing fluids below ambient temperature:
 - 1. Provide vapor barrier jackets, factory applied or field applied.
 - 2. Finish with glass cloth and vapor barrier adhesive.
 - 3. Insulate entire system.
- G. For insulated equipment containing fluids above ambient temperature:
 - 1. Provide standard jackets, with or without vapor barrier, factory applied or field applied.
 - 2. Finish with glass cloth and adhesive.
 - 3. For hot equipment containing fluids 140 degrees Fahrenheit (60 degrees Celsius) or less, do not insulate flanges and unions, but bevel and seal ends of insulation.
 - 4. For hot piping conveying fluids over 140 degrees Fahrenheit (60 degrees Celsius), insulate flanges and unions, including those at equipment, but label the insulation to indicate a concealed flange or union.
- H. Inserts and Shields:
 - 1. Application: Equipment 2 inches (50.8 mm) diameter or larger.
 - 2. Shields: Galvanized steel between hangers and inserts.
 - 3. Insert location: Between support shield and equipment and under the finish jacket.
 - 4. Insert configuration: Minimum 6 inches (152.4 mm) long, of same thickness and contour as adjoining insulation; may be factory fabricated.
 - 5. Insert material: Heavy density insulating material suitable for the planned temperature range.
- I. Finish insulation at supports, protrusions, and interruptions.
- J. For equipment in mechanical equipment rooms or in finished spaces, finish with aluminum jacket.
- K. For exterior applications, provide vapor barrier jacket or finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal equipment.
- L. Cover cellular glass and cellular foam insulation with aluminum jacket.
- M. Do not insulate over any nameplate or ASME stamps. Bevel and seal insulation around such.
- N. Install insulation for equipment requiring access for maintenance, repair, or cleaning, in such a manner that it can be easily removed and replaced without damage.
- O. All piping, equipment, ductwork, all plenums including metal and masonry construction, fans, etc., shall be insulated as indicated on the Drawings, as specified herein, and as required for a complete system. In each case, the insulation shall be equal to that specified and materials applied and finished as described in these Specifications.
- P. All insulation shall be applied by mechanics skilled in this particular work and regularly engaged in such occupation. All insulation shall be applied in strict accordance with these Specifications and with factory printed recommendations on items not herein mentioned. Unsightly,

inadequate, or sloppy work will not be acceptable, and all such work shall be removed and replaced as many times as necessary to achieve an acceptable installation.

- Q. All insulation, jacket, adhesives, mastics, sealers, etc., utilized in the fabrication of these systems shall meet NFPA for fire resistant ratings (maximum of 25 flame spread and 50 smoke developed ratings) and shall be approved by the insulation manufacturer for guaranteed performances when incorporated into their insulation system, unless a specific product is specified for a specific application, and is stated as an exception to this requirement. Certificates to this effect shall be submitted along with Contractor's submittal data for this section of the Specifications. No material may be used that, when tested by the ASTM E84-89 test method, is found to melt, drip or delaminate to such a degree that the continuity of the flame front is destroyed, thereby resulting in an artificially low flame spread rating.
- R. All surfaces to be insulated shall be clean and dry before applying the insulation. All sections of molded pipe covering shall be firmly butted together. Where an insulation covering is applied, it shall lap the adjoining section of insulation by at least three inches (3"). Where insulation terminates, it shall be neatly beveled and finished. No insulation shall be applied until the pipe, duct, etc., have been pressure tested and found tight. Piping, flexible connections, flanges, valves, strainers, and unions shall be covered unless specifically noted otherwise. Flexible connections on duct shall not be covered. All materials used shall be fire retardant or nonflammable. Refer to Section 15A.
- S. Where vapor barriers are required, the vapor barrier shall be on the outside. Extreme care shall be taken that the vapor barrier is unbroken. Joints, etc., shall all be sealed. Where insulation with a vapor barrier terminates, it shall be sealed off with the vapor barrier being continuous to the surface being insulated. Ends shall not be left raw.
- T. Extreme care shall be taken in covering high and medium pressure (high and medium pressure ductwork shall be all ductwork between the fan discharge and all mixing boxes) ductwork to insure the duct is not pierced with sheet metal screws or other fasteners. All high and medium pressure ducts in these specifications are classified as high velocity ductwork.
- U. Where specified, aluminum bands shall be used on piping insulation. The bands shall be applied three (3) to a section of pipe. Fittings, valves, etc., shall have bands on each side.
- V. Where canvas finish is specified, use Arabol lagging adhesive to prevent mildew in securing canvas. Do not use wheat paste. In addition, cover all canvas insulation with a fire retardant coating.
- W. For purpose of definition in this Specification: "concealed" areas are those areas which cannot be seen by the building occupants, and "exposed" areas are all areas which are exposed to view by the building occupants, including under counter and inside cabinet areas, plus all mechanical rooms.
- X. The handling and installation of all insulation materials shall be performed in strict accordance with the manufacturer's recommendations.

3.03 SCHEDULE

Equipment	Type	Insulation Thickness
Hot Expansion Tanks	E	2"
Provide aluminum Jacket		
Chilled Water Expansion Tanks	E	2"
Provide aluminum Jacket		
Air Separators	E	1"
Heat exchanger	D	2 1/2"

Provide aluminum Jacket		
Cold Surfaces (Not Factory Insulated)	E	1 ½ "
Chilled and Hot Water Pump Bodies	E	2"
Provide aluminum Jacket Chemical Feed (Chilled/Hot Water)	E	3/4"

END OF SECTION

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Coordinate with Commissioning Requirements indicated in Section 019113. This contractor is responsible to comply with all requirements for the above section.

SUMMARY

- A. This Section includes the following:
 - 1. Section 230500 Common Work Results in HVAC
 - 2. Section 230553 Mechanical Identification
 - 3. Section 230593 System Testing, Adjusting & Balancing
 - 4. Section 230523 Energy Management and Control Systems
 - 5. Section 233300 Ductwork Accessories
 - 6. Section 237413 Packaged Rooftop Air Conditioning Units

BUILDING AUTOMATION SYSTEM - GENERAL DESCRIPTION

- A. Provide a new Building Automation System (BAS) to integrate and control all mechanical equipment associated with this project.
 - 1. The Building Automation System shall be as indicated on the drawings and described in these specifications. System must be fully integrated and coordinated with mechanical equipment DDC controllers furnished and installed in the equipment manufacturer's factory as specified in those sections. The intent of the BAS is to integrate all mechanical equipment into one system for global monitoring, control, and alarming associated with the building. It is the BAS manufacturer's responsibility to provide all the design, engineering, and field coordination required to ensure all equipment sequence of operations are met as specified and the designated BAS operators have the capability of managing the building mechanical system to ensure occupant comfort while maintaining energy efficiency.
 - 2. The BAS shall meet open standard protocol communication standards (As defined in System Communications Section) to ensure the system maintains "interoperability" to avoid proprietary arrangements that will make it difficult for the Owner to consider other BAS manufacturers in future projects.
 - 3. Direct Digital Control (DDC) technology shall be used to provide the functions necessary for control of mechanical systems and terminal devices on this project.
 - 4. Approved vendors, products and web services shall comply with SOC2 Type I as defined by the AICPA. SOC2 Type 1 compliance is a certification that confirms that a service provider has established and implemented effective controls to secure their clients' data in accordance with the Trust Services Criteria (TSC).
 - a. SOC2 Type 1 compliance provides assurance to customers that the service provider has established and implemented effective security controls and is committed to protecting their data.
 - b. To achieve SOC2 Type 1 compliance, the manufacturer shall have completed an independent audit to assess design and implementation of their controls, policies, and procedures.
 - 5. The BAS shall accommodate simultaneous multiple user operation. Access to the control system data should be limited only by the security permissions of the operator role. Multiple users shall have access to all valid system data. An operator shall be able to log onto any workstation on the control system and have access to all appropriate data.

APPROVED CONTROL SYSTEM MANUFACTURES

- A. Approved BAS Manufacturers

1. Trane Tracer – Basis of Design
2. Approved Equal

QUALITY ASSURANCE

A. BAS Manufacturer Qualifications

1. The BAS manufacturer shall have an established business office within 50.00 miles (80.47 kilometers) of the project site and must provide 24 hours/day, 7 days/week response in the event of a customer warranty or service call.
2. The BAS Manufacturer shall have factory trained and certified personnel providing all engineering, service, startup, and commissioning field labor for the project from their local office location. BAS manufacturer shall be able to provide training certifications for all local office personnel upon request.
3. The BAS shall be provided by a single manufacturer and this manufacturer's equipment must consist of operator workstation software, Web-based hardware/software, Open Standard Protocol hardware/software, Custom application Programming Language, Graphical Programming Language, Building Controllers, Custom Application Controllers, and Application Specific Controllers. All other products specified herein (i.e., sensors, valves, dampers, actuators, etc.) need not be manufactured by the BAS manufacturer listed in this specification.
4. Independent representatives of BAS manufacturers are not acceptable. BAS vendor must be corporate owned entity of BAS manufacturer.

CODES AND STANDARDS

A. Codes and Standards: Meet requirements of all applicable standards and codes, except when more detailed or stringent requirements are indicated by the Contract Documents, including requirements of this Section.

1. Underwriters Laboratories: Products shall be UL 916-PAZX listed.
2. National Electrical Code -- NFPA 70.
3. Federal Communications Commission -- Part J.
4. ASHRAE/ANSI 135-2012 (BACnet) - (System Level Devices) - Building Controllers shall conform to the listed version of the BACnet specification in order to improve interoperability with various building system manufacturers' control systems and devices.
5. ASHRAE/ANSI 135-2012 (BACnet) - (Unit Level Devices) - Unit Controllers shall conform to the listed version of the BACnet specification in order to improve interoperability with various building system manufacturers' control systems and devices.

SYSTEM PERFORMANCE

A. Performance Standards. The BAS system shall conform to the following:

1. Graphic Display. The system shall display a graphic with a minimum of 20 dynamic points. All current data shall be displayed within 10 seconds of the operator's request.
2. Graphic Refresh. The system shall update all dynamic points with current data within 10 seconds.
3. Object Command. The maximum time between the command of a binary object by the operator and the reaction by the device shall be 5 seconds. Analog objects shall start to adjust within 5 seconds.
4. Object Scan. All changes of state and change of analog values shall be transmitted over the high-speed network such that any data used or displayed at a controller or workstation will be current within the prior 10 seconds.
5. Alarm Response Time. The maximum time from when an object goes into alarm to when it is annunciated at the workstation shall not exceed 10 seconds.
6. Program Execution Frequency. Custom and standard applications shall be capable of running as often as once every 5 seconds. The Contractor shall be responsible for selecting execution times consistent with the mechanical process under control.

7. Programmable Controllers shall be able to execute DDC PID control loops at a selectable frequency from at least once every 5 seconds. The controller shall scan and update the process value and output generated by this calculation at this same frequency.
8. Multiple Alarm Annunciations. All workstations on the network shall receive alarms within 5 seconds of each other.

SUBMITTAL REQUIREMENTS

- A. BAS manufacturer shall provide shop drawings and manufacturers' standard specification data sheets on all hardware and software being provided for this project. No work may begin on any segment of this project until the Engineer and Owner have reviewed submittals for conformity with the plan and specifications.
 1. Provide electronic submittal package in PDF format for review and approval.
- B. Quantities of items submitted shall be reviewed by the Engineer and Owner. Such review shall not relieve the BAS manufacturer of furnishing quantities required based upon contract documents.
- C. Provide the Engineer and Owner, any additional information or data which is deemed necessary to determine compliance with the specifications or which is deemed valuable in documenting and understanding the system to be installed.
- D. All shop drawings shall be provided to the Owner electronically as .dwg or .dxf file formats once they have been approved and as-built drawings have been completed.
- E. Submit the following within 90 days of contract award:
 1. A complete bill of materials of equipment to be used indicating quantities, manufacturers and model numbers.
 2. A schedule of all control valves including the valve size, pressure drop, model number (including pattern and connections), flow, CV, body pressure rating, and location.
 3. A schedule of all control dampers including damper size, pressure drop, manufacturer, and model number.
 4. Provide all manufacturers' technical cut sheets for major system components. When technical cut sheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Include:
 - a. Building Controllers
 - b. Custom Application Controllers
 - c. Application Specific Controllers
 - d. Operator Workstations
 - e. Portable Operator Terminals
 - f. Auxiliary Control Devices
 5. Provide proposed Building Automation System architectural diagram depicting various controller types, workstations, device locations, addresses, and communication cable requirements
 6. Provide detailed termination drawings showing all required field and factory terminations, as well as terminal tie-ins to DDC controls provided by mechanical equipment manufacturers. Terminal numbers shall be clearly labeled.
 7. Provide a sequence of operation for each controlled mechanical system and terminal end devices.
 8. Provide a BACnet Protocol Implementation Conformance Statement (PICS) for each BACnet system level device (i.e. Building Controller & Operator Workstations) type. This defines the points list for proper coordination of interoperability with other building systems if applicable for this project.

- F. Project Record Documents: Upon completion of installation, submit three (3) copies of record (as-built) documents. The documents shall be submitted for approval prior to final completion and include:
1. Project Record Drawings - These shall be as-built versions of the submittal shop drawings. One set of electronic media including CAD .dwg and .pdf drawing files shall be provided.
 2. Testing and Commissioning Reports and Checklists signed off by trained factory (equipment manufacturers) and field (BAS) commissioning personnel.
 3. Operating and Maintenance (O & M) Manuals - These shall be as-built versions of the submittal product data. In addition to the information required for the submittals, Operating & Maintenance manual shall include:
 - a. Procedures for operating the BAS including logging on/off, alarm management, generation of reports, trends, overrides of computer control, modification of setpoints, and other interactive system requirements.
 - b. Explanation of how to design and install new points, new DDC controllers, and other BAS hardware.
 - c. Documentation, installation, and maintenance information for all third party hardware/software products provided including personal computers, printers, hubs, sensors, valves, etc.
 - d. Original issue media for all software provided, including operating systems, programming language, operator workstation software, and graphics software.
 - e. Licenses, Guarantee, and Warranty documents for all equipment and systems.
- G. Training Manuals: The BAS manufacturer shall provide a course outline and copies of training manuals at least two weeks prior to the start of any corporate training class to be attended by the Owner.

WARRANTY REQUIREMENTS

- A. Warrant all work as follows:
1. BAS system labor and materials shall be warranted free from defects for a period of twelve (12) months after final completion acceptance by the Owner. BAS failures during the warranty period shall be adjusted, repaired, or replaced at no charge to the Owner. The BAS manufacturer shall respond to the Owner's request for warranty service within 24 hours of the initiated call and will occur during normal business hours (8AM-5PM).
 2. At the end of the final start-up/testing, if equipment and systems are operating satisfactorily to the Owner and Engineer, the Owner shall sign certificates certifying that the BAS is operational, and has been tested and accepted in accordance with the terms of this specification. The date of Owner's acceptance shall be the start of the warranty period.
 3. To ensure that the owner will have the most current operating system provided by the manufacturer, the BAS manufacturer shall include licensing and labor costs to facilitate software/firmware updates throughout the warranty period at no charge to the owner. These updates shall include upgrades for functional enhancements associated with the following: operator workstation software, project specific software, graphics, database, firmware updates, and all security related service packs. Written authorization by the Owner must be granted prior to the installation of these updates.
 4. The BAS manufacturer shall provide a web-accessible Users Network for the proposed System and give the Owner free access to question/answer forum, user tips, upgrades, and training schedules for a one year period of time correlating with the warranty period.

SYSTEM MAINTENANCE AND REMOTE ANALYSIS

- A. The BAS Manufacture shall provide Building Automation System remote support and system analysis for a period of 1 year (beginning the date of substantial completion).

- B. The BAS manufacturer shall setup a secure remote connection for data collection, analytics and remote technical support for the HVAC systems included in this contract.
 - 1. Provide technician support during the warranty period to diagnose issues remotely through the secure remote connection.
 - 2. The building owner is responsible for providing adequate internet access.
- C. Connectivity / Remote Access / Network Security
 - 1. Provide and maintain secure remote access to the facilities Building Automation System (BAS) or other building systems. Users accessing service through this connection shall not have access to the building owners network. Secure remote access to the BAS shall not require ANY inbound ports on a firewall to be "exposed" or "forwarded".
 - 2. Secure remote access to the BAS shall be available anywhere, anytime, using a compatible client device (PC/tablet/phone)
 - 3. The Owner will provide up to Three (3) IP drops and IP addresses on the owners network to gain access to the internet. The BAS manufacture shall coordinate with the Owners IT team, verify the proposed system shall meet all network security requirements and any other network configuration information necessary to each control contractor for the purpose of configuring each Area Controller on the network. It shall be the responsibility of the BAS manufacture to coordinate with the owner for network connectivity.
- D. The BAS Manufacture shall provide a professional analysis for the facility HVAC systems.
 - 1. The analysis shall consist of an evaluation of HVAC systems including charts and graphs which indicate both current building performance and opportunities for building and HVAC system performance improvement.
- E. The following shall be provided after substantial completion of the project:
 - 1. Orientation meeting with the building owner's representative to identify the HVAC systems that will be evaluated.
 - 2. System setup for data collection and analytics. BAS Manufacture to setup a secure remote data collection and analytics for identified systems.
 - 3. Assessment analysis shall be performed by trained personnel with relevant professional credentials in HVAC systems, energy management and building optimization methodologies.
 - 4. Consultation meeting with owner to review performance reports and improvement opportunities.
- F. Do not assign or transfer maintenance service to agent or subcontractor without prior written consent of owner.

OWNERSHIP OF PROPRIETARY MATERIAL

- A. Project specific software and documentation shall become the owner's property upon project completion. This includes the following:
 - 1. Operator Graphic files
 - 2. As-built hardware design drawings
 - 3. Operating & Maintenance Manuals
 - 4. BAS System software database

DEFINITIONS

- A. DDC: Direct digital control
- B. I/O: Input/output.
- C. MS/TP: Manager Subordinate / Token Passing.
- D. POT: Portable Operator's Terminal.
- E. PID: Proportional plus integral plus derivative.
- F. RTD: Resistance temperature detector.

G. BAS/ATC: Building Automation System/Automatic Temperature Controls.

PART 2 - PRODUCTS

13.01 SECTION INCLUDES

- A. MATERIALS:
- B. VARIABLE AIR SYSTEM - COMMUNICATIONS
- C. VARIABLE AIR SYSTEM - OPERATOR INTERFACE
- D. VARIABLE AIR SYSTEM - CONTROLLER SOFTWARE
- E. VARIABLE AIR SYSTEM - BUILDING / SYSTEM CONTROLLERS
- F. ADVANCED APPLICATION CONTROLLERS:
- G. APPLICATION SPECIFIC CONTROLLERS:
- H. APPLICATION CONTROLLER for Packaged Rooftop Units
- I. VARIABLE AIR VOLUME TERMINAL UNIT CONTROLLERS
- J. VARIABLE AIR SYSTEM - BYPASS DAMPER CONTROLLER
- K. INPUT/OUTPUT INTERFACE:
- L. BAS – SOFTWARE SERVICE TOOLS
- M. POWER SUPPLIES:
- N. AUXILIARY CONTROL DEVICES:
- O. WIRING AND RACEWAYS:

13.02 REFERENCE STANDARDS

- A. IEEE 802.15.4 - IEEE Standard for Low-Rate Wireless Networks; 2024.
- B. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- C. UL 94 - Tests for Flammability of Plastic Materials for Parts in Devices and Appliances; Current Edition, Including All Revisions.
- D. UL 916 - Energy Management Equipment; Current Edition, Including All Revisions.

MATERIALS:

- A. Use new products that the manufacturer is currently manufacturing and that have been installed in a minimum of 25 installations. Do not use this installation as a product test site unless explicitly approved in writing by the owner or the owner's representative. Spare parts shall be available for at least five years after completion of this contract.

VARIABLE AIR SYSTEM - COMMUNICATIONS

- A. System Communications
 - 1. Each workstation, building controller, and equipment controller communication interface shall utilize the BACnet protocol with an Ethernet (IEEE 802.3, 802.11), RS485 (EIA-485), or Zigbee (802.15.4) physical interface and an appropriate data link technology as defined in ANSI®/ASHRAE® Standard 135-2012. (e.g. BACnet IP, BACnet IPv6, BACnet MS/TP, BACnet Zigbee).
 - 2. All system controllers shall be BTL listed as a BACnet Building Controller (B-BC) as defined in ANSI®/ASHRAE® Standard 135-2012.
 - 3. All documented status and control points, schedule, alarm, and data-log services or objects shall be available as standard object types as defined in ANSI®/ASHRAE® Standard 135-2012.

4. Each System Controller shall communicate with a network of Custom Application and Application Specific Controllers utilizing one or more of the interfaces documented within Field Bus Communications below.
 5. For minimally managed IP networks, BACnet communication shall support BACnet Secure Connect (BACnet/SC), a secure and encrypted datalink layer specifically design for those networks.
- B. Field Bus Communications
1. BACnet
 - a. All equipment and plant controllers shall be BTL listed as a BACnet Application Specific Controller (B-ASC) or a BACnet Advanced Application Controller (B-AAC) as defined in ANSI®/ASHRAE® Standard 135-2012.
 - b. All communication shall conform to ANSI®/ASHRAE® Standard 135-2012.
 - c. System Controller shall function as a BACnet router to each unit controller providing a globally unique BACnet Device ID for all BACnet controllers within the system.
 - d. BACnet Zigbee
 - 1) Communication between System Controller and equipment/plant controllers shall utilize BACnet Zigbee as defined in ANSI®/ASHRAE® Standard 135-2012.
 - 2) Each equipment controller wireless communication interface shall self-heal to maintain operation in the event of network communication failure.
 - 3) Each zone sensor wireless communication interface shall be capable of many-to-one sensors per controller to support averaging, monitoring, and multiple zone applications. Sensing options shall include temperature, relative humidity, CO2, and occupancy.
 - e. BACnet MS/TP
 - 1) Communication between System Controller and equipment/plant controllers shall utilize BACnet MS/TP as defined in ANSI®/ASHRAE® Standard 135-2012.

VARIABLE AIR SYSTEM - OPERATOR INTERFACE

- A. Provide Operator Web Interface to allow system operators to view and adjust Variable Air System status, set-points and alarms.
1. Manufacturer shall provide a user interface with time-of-day schedules, data collection, dashboards, reports and building summary, system applications, and self-expiring timed overrides. Manufacturer shall provide a published user and applications guide(s) that detail the system application operation, configuration, setup and troubleshooting.
 2. The building operator web interface shall be accessible via a web browser without requiring any "plug-ins" (i.e. JAVA Runtime Environment (JRE), Adobe Flash).
 3. User Roles
 - a. The system shall include pre-defined "roles" that allow a system administrator to quickly assign permissions to a user.
 - b. User logon/logoff attempts shall be recorded.
 - c. The system shall protect itself from unauthorized use by automatically logging off following the last keystroke. The delay time shall be user definable.
 4. On-Line Help and Training
 - a. Provide a context sensitive, on line help system to assist the operator in operation and configuration of the system.
 - b. On-line help shall be available for all system functions and shall provide the relevant data for each particular screen.
 5. Equipment and Application Pages
 - a. The operator web interface shall include standard pages for all equipment and applications. These pages shall allow an operator to obtain information relevant to the operation of the equipment and/or application, including:

-
- 1) Animated Equipment Graphics for each major piece of equipment and floor plan in the System. This includes:
 - (a) Each Chiller, Air Handler, VAV Terminal, Fan Coil, Boiler, and Cooling Tower. These graphics shall show all points dynamically as specified in the points list.
 - (b) Animation capabilities shall include the ability to show a sequence of images reflecting the position of analog outputs, such as valve or damper positions. Graphics shall be capable of launching other web pages.
 - 2) Alarms relevant to the equipment or application without requiring a user to navigate to an alarm page and perform a filter.
 - 3) Historical Data (As defined in Data Log section below) for the equipment or application without requiring a user to navigate to a Data Log page and perform a filter.
 6. Provide Variable Air System graphics: An operator shall be able to view and control (where applicable) the following parameters via the operator web interface:
 - a. System Mode
 - b. System Occupancy
 - c. Ventilation (Outdoor air flow) setpoint
 - d. Ventilation (Outdoor air flow) status
 - e. Air Handler Static pressure setpoint
 - f. Air Handler Static pressure status
 - g. Air Handler Occupancy status
 - h. Air Handler Supply air cooling and heating set points
 - i. Air Handler minimum, maximum and nominal static pressure setpoints
 - j. VAV box minimum and maximum flow
 - k. VAV box drive open and close overrides
 - l. VAV box Airflow to space
 - m. Average space temperature
 - n. Minimum space temperature
 - o. Maximum space temperature
 7. System Graphics. Building operator web interface shall be graphically based and shall include at least one graphic per piece of equipment or occupied zone, graphics for each chilled water and hot water system, and graphics that summarize conditions on each floor of each building included in this contract. Indicate thermal comfort on floor plan summary graphics using colors to represent zone temperature relative to zone set point.
 - a. Graphic imagery – graphics shall use 3D images for all standard and custom graphics. The only allowable exceptions will be photo images, maps, schematic drawings, and selected floor plans.
 - b. Animation. Graphics shall be able to animate by displaying different Image lies for changed object status.
 - c. Alarm Indication. Indicate areas or equipment in an alarm condition using color or other visual indicator
 8. Graphics Library. Furnish a library of standard HVAC equipment such as chillers, air handlers, terminals, fan coils, unit ventilators, rooftop units, and VAV boxes, in 3-dimensional graphic depictions. The library shall be furnished in a file format compatible with the graphics generation package program
 9. Manual Control and Override.
 - a. Point Control. Provide a method for a user to view, override, and edit if applicable, the status of any object and property in the system. The point status shall be available by menu, on graphics or through custom programs.

-
- b. Temporary Overrides. The user shall be able to perform a temporary override wherever an override is allowed, automatically removing the override after a specified period of time.
 - c. Override Owners. The system shall convey to the user the owner of each override for all priorities that an override exists.
 - d. Provide a specific icon to show timed override or operator override, when a point, unit controller or application has been overridden manually.
 - 10. Scheduling. - The scheduling application shall provide graphical representation of the day, week, month and exception events.
 - 11. Alarm/Event Notification
 - a. Alarm/Event Log. The operator shall be able to view all logged system alarms/events from any building operator web interface.
 - 1) The operator shall be able to sort and filter alarms from events. Alarms shall be sorted in a minimum of 4 categories based on severity.
 - 2) The operator shall be able to acknowledge and add comments to alarms
 - 3) Alarm/event messages shall use full language, easily recognized descriptors.
 - b. Alarm Suppression. Alarms shall be able to be suppressed based on load/source relationships to present the likely root cause to the building operator as described in ASHRAE Guideline 36. Load/Source relationships shall be configurable by the user through a web interface.
 - 12. Reports and Logs.
 - a. The building operator web interface shall provide a reporting package that allows the operator to select reports.
 - b. The building operator web interface shall provide the ability to schedule reports to run at specified intervals of time.
 - c. The following standard reports shall be available without requiring a user to manually configure the report:
 - 1) All Points in Override Report: Provide an on demand report showing all overrides in effect.
 - 2) Commissioning Report: Provide a one-time report that lists all equipment with the unit configuration and present operation.
 - 3) All Points in Alarm Report: Provide an on demand report showing all current alarms.
 - 4) Points report: Provide a report that lists the current value of all points
 - d. The controls vendor shall provide a hardening report that summarizes the port configuration details to ensure sites have not been exposed to the Internet in alignment with Cyber Security best practices.
 - B. Provide Local Occupant Interface – Touch sensitive display
 - 1. Provide a color touch sensitive display that allows the building occupants to accomplish the following tasks:
 - a. Occupant override of the system/equipment operating mode shall be possible with a single touch on the local operator display. With the ability to set up point overrides to expire at designated times
 - b. The local operator display shall provide occupant access to system time of day scheduling. Occupants shall have the ability to schedule events more than one year in advance. Exception schedules and holidays shall be shown clearly on the calendar, visible to the occupant on the touchscreen display.
 - c. The local operator display shall offer PIN control, which shall limit system control access to only those with proper login credentials.
 - d. The local operator display shall display the alerts that require service of the connected equipment.

2. To ensure interoperability with the Building Automation System (BAS), the local operator display shall be provided by the BAS solution provider associated with this project.
3. Local operator display shall be a minimum of 10 inches (254 mm) in size and be provided with mounting hardware to allow it to be installed on an office wall or control panel door.

VARIABLE AIR SYSTEM - CONTROLLER SOFTWARE

- A. Variable Air System Controls Manufacturer shall provide standard applications to deliver HVAC system control. Standard applications include Time of Day Scheduling with Optimal Start/Stop, VAV Air Systems Control, Chiller Plant Control, Historical Trend Logs and Trim and Respond. Manufacturer shall provide system optimization strategies for functions such as fan pressure optimization and ventilation optimization.
- B. Furnish the following applications software for building and energy management. All software applications shall reside and run in the system controllers. Editing of applications shall occur at the building operator interface.
 1. VAV Air Systems Applications
 - a. The BAS shall provide air system applications that coordinate air handlers (AHU)/rooftop units (RTU) and Variable Air Volume Terminal equipment.
 - b. The air system applications shall perform the following functions:
 - 1) Startup and shutdown the air handler safely. Ensure the VAV boxes are open sufficiently when the air handler is running, to prevent damage to the ductwork and VAV boxes due to high air pressure.
 - 2) Demand Controlled Ventilation – the active ventilation setpoint shall modulate between the occupied ventilation and occupied standby ventilation setpoint; Resetting the setpoint based on CO2 levels in the space.
 - c. The Air Systems application shall provide a user interface that includes status of current system operation with real time data of key operating parameters. Key operating parameters include:
 - 1) Duct Static Pressure
 - 2) Duct Static Optimization Maximum VAV Damper/Source VAV Box
 - 3) Discharge Air Temperature
 - d. The air system application status screens shall explain what optimization calculations are occurring, critical parameters, and source equipment members.
 - e. The air systems applications shall provide a user interface that enables configuration changes made by swipe and type fields, selection list, and check box entry for feature definition:
 - 1) VAV Auxiliary Night Heat
 - 2) VAV Source Temperature Distribution
 - 3) Start/Stop Delay operation
 - 4) Enable/Disable Optimization Strategies
 - f. The operation of VAV Terminal equipment members of the VAV Air System shall be selected by check box to optionally participate in the following functions:
 - 1) System calculations (min, max, average)
 - 2) Ventilation Optimization
 - 3) Drive to Maximum Override
 - 4) Common Source Temperature
 - 5) Common Space
 - 6) Discharge Air Temperature Optimization
 - g. The air system application vendor shall provide a published applications guide that details the air system application operation, configuration, setup, and troubleshooting. The applications guide documentation shall be maintained under version control, and updated by the manufacture to reflect most recent feature updates as made available. Contents of the guide shall include:

-
- 1) Description of System Operation
 - 2) Required Components
 - 3) Sequences of Operation
 - 4) Installation
 - 5) Controller Setup
 - 6) Required Programming
 - 7) Commissioning
 - 8) Optimization Strategies
 - 9) Special Applications
 - 10) Troubleshooting
- h. The air system application shall present in plain user language the current operation with source zone information and reset events.
- C. Trend Logs
1. The system shall harvest trend logs for defined key measurements for each controlled HVAC device and HVAC application. Trend logs shall be captured for a minimum of 5 key operating points for each piece of HVAC equipment and HVAC application and stored for no less than 1 year at 15-minute intervals. Data Logs shall be capable of being configured on an interval or change of value basis.
 - a. Variable Air System (VAS)
 - 1) Space Temperature Average
 - 2) Ventilation Optimization Air Setpoint
 - 3) Operating Mode
 - b. Air Handling Unit/Rooftop (VAV)
 - 1) Discharge Air Temperature
 - 2) Discharge Air Temperature Setpoint Active
 - 3) Space Temperature Active
 - 4) Cooling Capacity Status
 - 5) Discharge Air Flow
 - c. VAV box
 - 1) Discharge Air Temperature
 - 2) Space Temperature Active
 - 3) Space Temperature Setpoint Active
 - 4) Air Flow Setpoint Active
 - 5) Discharge Air Flow

VARIABLE AIR SYSTEM - BUILDING / SYSTEM CONTROLLERS

- A. There shall be one or more independent, standalone microprocessor based System Controllers to manage the global strategies described in CONTROLLER SOFTWARE section.
 1. The controller shall provide a USB communications port for connection to a PC.
 2. The operating system of the Controller shall manage the input and output communications signals to allow distributed controllers to share real and virtual point information and allow central monitoring and alarms.
 3. All System Controllers shall have a real time clock and shall be able to accept a BACnet time synchronization command for automatic time synchronization.
 4. Data shall be shared between networked System Controllers.
 5. Serviceability – The System Controller shall have a display on the main board that indicates the current operating mode of the controller.
- B. Controls manufacturer shall provide secure remote access to the Building Automation System (BAS). Secure remote access shall not require IP ports to be "exposed" (i.e. port-forwarded or external public IP addresses) to the Internet. Controls manufacturer shall update secure

remote access software as necessary to follow cyber security best practices and respond to cyber security events.

ADVANCED APPLICATION CONTROLLERS:

- A. Advance Application Controllers shall be used to control all equipment or applications of medium and high complexity, including but not limited to Air Handlers, Boiler Plants and Chiller Plants.
- B. The Advanced Application Controller shall be capable of operating as a stand-alone controller or as a member of a Building Automation System (BAS).
- C. When the Advanced Application Controller is operating as a member of a Building Automation System (BAS), the application controller shall operate as follows:
 - 1. Application Controller will receive operation mode commands from the BAS network controller. The BAS commands shall include but not be limited to the follow: Occupied Heat/Cool, Unoccupied Heat/Cool, Morning Warm-up, / Pre-cool, Occupied Bypass).
 - 2. Application Controller will provide equipment status parameters to the BAS through BACnet communication.
 - 3. Application Controller will operate as a stand-alone controller in the event of communication failure with the BAS.
 - 4. In case of communications failure, stand-alone operation shall use default values or last known values for remote sensors read over the network such as outdoor air temperature.
- D. For Stand-Alone Operation of Advanced Application Controllers:
 - 1. Shall operate a schedule in a standalone application using a Real Time Clock with a 7 day power backup.
 - a. The Controller shall have a built in schedule (assessable with or without a display)
 - b. Support will be for at least 3 schedules with up to 10 events for each day of the week.
 - c. Each of the 3 schedules can be Analog, Binary or Multi-State
 - d. The controller shall support a minimum of 25 exceptions each with up to 10 events.
- E. For ease of troubleshooting, the Controller shall support data trend logging.
 - 1. With a minimum of 20,000 trending points total on a controller
 - 2. Trends shall be capable of being collected at a minimum sample rate of once every second
 - 3. Shall be capable of trending all BACnet points used by controller
 - 4. Trends shall be capable of being scheduled or triggered.
- F. To meet the sequence of operation for each application, the Controller shall use library programs provided by the controller manufacturer that are either factory loaded or downloaded with service tool to the controller.
- G. Environment. Controller hardware shall be suitable for the anticipated ambient conditions.
 - 1. Operating conditions:
 - a. Temperature: -40°F to 158°F (-40°C to 70°C)
 - b. Relative Humidity: 5% to 100% RH (non-condensing)
 - 2. Controllers used indoors shall be mounted in a NEMA 1 enclosure at a minimum.
 - 3. Controllers used outdoors and/or in wet ambient shall be mounted within NEMA 4 type waterproof enclosures, and shall be rated for operation at -40° F to 158° F -40° C to 70° C.
- H. Input/Output: The Controller shall have on board or through expansion module all I/O capable of performing all functionality needed for the application. Controls provided by the equipment manufacture must supply the required I/O for the equipment. In addition other controls must meet the following requirements:
 - 1. Shall support flexibility in valve type, the controllers shall be capable of supporting the following valve control types: 0-10VDC, 0-5VDC, 4-20mA, 24VAC - 2 position.

-
2. Shall support flexibility in sensor type, the Controller shall be capable of reading sensor input ranges of 0 to 10V, 0 to 20mA, 50ms or longer pulses, 200 to 20Kohm and RTD input.
 3. Shall support flexibility in sensor type, all Analog Outputs shall have the additional capability of being programmed to operate as Universal Inputs or Pulse Width Modulation Outputs.
 4. Shall support flexibility in sensor type, the Controller and/or expansion modules shall support dry and wetted (24VAC) binary inputs.
 5. The controller shall support pulse accumulator for connecting devices like energy meters.
 6. In order to support a wide range of devices, the Controller's binary output shall be able to drive at least 10VA each.
 7. For future needs, any unused I/O that is not needed for the functionality of the equipment shall be available to be used by custom programs on the Controller and by any other controller on the network.
 8. The Controller shall provide 24VAC and 24VDC power terminals sensors and other devices required.
 9. The Controller shall provide a dedicated static pressure input.
 - I. Input/Output Expandability – The Controller shall provide the following functionality in order to meet current and future application needs:
 1. For the application flexibility, the Controller shall be capable of expanding to a total of at least 100 hardware I/O terminations.
 2. Expansion I/O can be mounted up to 650 feet (19812 cm) from control.
 3. For optimized system operation, expansion I/O must communicate via an internal controller communication bus (point expansion via the BACnet MS/TP network is not allowed).
 - J. Serviceability – The Controller shall provide the following in order to improve serviceability of the Controller.
 1. Diagnostic LEDs for power/normal operation/status, BACnet communications, sensor bus communications, and binary outputs. All wiring connections shall be clearly labeled and made to be field removable.
 2. Binary and analog inputs and outputs shall use removable connectors or be connected to terminal strip external to the control box.
 3. Software service tool connection through the following methods: direct cable connection to the Controller, connection through another controller on BACnet link
 4. For safety purposes, the controller shall be capable of being powered by a portable computer's USB port for the purposes of configuration, programming and testing programs so that this work can be accomplished with the power off to the associated equipment.
 5. The Controller software tool service port shall utilize standard off-the-shelf USB printer cable.
 6. Capabilities to temporarily override the BACnet point values with built-in time expiration in the Controller.
 7. To aid in service replacement, the Controller shall easily attached to standard DIN rail mounting.
 8. For future expansion, the Controller shall be capable of adding sequence of operation programming utilizing service tools software with a graphical programming interface (editing or programming in line code is not permissible).
 9. To aid in service replacement, the Controller shall allow for setting its BACnet address via controller mounted rotary switches that correspond to the numerical value of the address. (DIP switch methodologies are not allowed). Setting of the address shall be accomplished without the need of a service tool or power applied to the controller.
 10. Controller data shall be maintained through a power failure.

- K. Software Retention: All Controller operating parameters, setpoints, BIOS, and sequence of operation code must be stored in non-volatile memory in order to maintain such information for months without power.
- L. Controller must meet the following Agency Compliance:
 - 1. UL 916 PAZX, Open Energy Management Equipment
 - 2. UL 94-5V, Flammability
 - 3. FCC Part 15, Subpart B, Class B Limit
 - 4. BACnet Testing Laboratory (BTL) listed as BACnet Advanced Application Controller (B-AAC)

APPLICATION SPECIFIC CONTROLLERS:

- A. General Description
 - 1. Application Specific Controllers (ASC) shall be microprocessor-based DDC controllers which, through hardware or firmware design, control specified equipment. They are not user programmable, but are customized for operation within the confines of the equipment they are designed to serve.
 - 2. Zone Controllers are controllers that operate equipment that control the space temperature of single zone. Examples are controllers for VAV, Fan coil, Blower Coils, Unit Ventilators, Heat Pumps, and Water Source Heat Pumps.
- B. The Application Specific Controller shall be capable of operating as a stand-alone controller or as a member of a Building Automation System (BAS).
- C. When the Application Specific Controller is operating as a member of a Building Automation System (BAS), the application controller shall operate as follows:
 - 1. Application Controller will receive operation mode commands from the BAS network controller. The BAS commands shall include but not be limited to the follow: Occupied Heat/Cool, Unoccupied Heat/Cool, Morning Warm-up, / Pre-cool, Occupied Bypass).
 - 2. Application Controller will provide equipment status parameters to the BAS through BACnet communication.
 - 3. Application Controller will operate as a stand-alone controller in the event of communication failure with the BAS.
 - 4. In case of communications failure stand-alone operation shall use default values or last known values for remote sensors read over the network such as outdoor air temperature.
- D. Stand-Alone Operation: Each piece of equipment specified in section "A" shall be controlled by a single controller and provide stand-alone control in the event that a BAS is not present.
- E. Software
 - 1. To meet the sequence of operation for each zone control, the controller shall use programs developed and tested by the controller manufacturer that are either factory loaded or downloaded with service tool to the controller.
 - 2. For controlling ancillary devices and for flexibility to change the sequence of operation in the future, the controller shall be capable running custom programs written in a graphical programming language.
- F. Environment: Controller hardware shall be suitable for the anticipated ambient conditions.
 - 1. Storage: -55° to 203° F (-48° to 95° C) and 5 to 95% Rh, non-condensing.
 - 2. Operating: -40° to 158° F (-40 to 70° C) and 5 to 95% Rh, non-condensing.
 - 3. Controllers used indoors shall be mounted in a NEMA 1 enclosure at a minimum.
 - 4. Controllers used outdoors and/or in wet ambient shall be mounted within NEMA 4 type waterproof enclosures, and shall be rated for operation at -40° to 158° F -40° to 70° C.
- G. Input/Output:

1. For flexibility in selection and replacement of valves, the controllers shall be capable of supporting all of the following valve control types 0-10VDC, 0-5VDC, 4-20mA, 24VAC floating point, 24VAC - 2 position (Normally Open or Normally Closed).
 2. For flexibility in selection and replacement of sensors, the controllers shall be capable of reading sensor input ranges of 0 to 10V, 0 to 20mA, pulse counts, and 200 to 20Kohm.
 3. For flexibility in selection and replacement of binary devices, the controller shall support dry and wetted (24VAC) binary inputs.
 4. For flexibility in selection and replacement devices, the controller's shall have binary output which are able to drive at least 12VA each.
 5. For flexibility in selection and replacement of motors, the controller shall be capable of outputting 24VAC (binary output), DC voltage (0 to 10VDC minimum range) and PWM (in the 80 to 100 Hz range).
 6. For future needs, any I/O that is unused by functionality of equipment control shall be available to be used by custom program on the controller and by another controller on the network.
 7. For future expansion and flexibility, the controller shall have either on board or through expansion, 20 hardware input/output points. Expansion points must communicate with the controller via an internal communications bus. Expansion points must be capable of being mounted up to 650ft. 218.72 yard (200 meter) from the controller. Expansion points that require the BACnet network for communication with the controller are not allowed.
- H. Serviceability – The controller shall provide the following in order to improve serviceability of the controller.
1. Diagnostic LEDs shall indicate correct operation or failures/faults for all of the following: power, sensors, BACnet communications, and I/O communications bus.
 2. All binary output shall have LED's indicating the output state.
 3. All wiring connectors shall removable without the use of a tool.
 4. Software service tool connection through all of the following methods: direct cable connection to the controller, connection through another controller on BACnet link
 5. For safety purposes, the controller shall be capable of being powered by a portable computer for the purposes of configuration, programming, and testing programs so that this work can be accomplished with the power off to the equipment.
 6. Capabilities to temporarily override of BACnet point values with built-in time expiration in the controller.
 7. BACnet MAC Address shall be set using decimal (0-9) based rotary switches.
 - a. Configuration change shall not be made in a programming environment, but rather by a configuration page utilizing dropdown list, check boxes, and numeric boxes.
 8. For ease of troubleshooting, the Controller shall support BACnet data trend logging.
 - a. With a minimum of 20,000 trending points total on controller
 - b. Trends shall be capable of being collected at a minimum sample rate of once every second.
 - c. Shall be capable of trending all BACnet points used by controller
 - d. Trends shall be capable of being scheduled or triggered
- I. Software Retention: All Zone Controller operating parameters, setpoints, BIOS, and sequence of operation code must be stored in non-volatile memory in order to maintain such information for months without power.
- J. Application controller shall meet the following Agency Compliance:
1. UL 916 PAZX, Open Energy Management Equipment
 2. UL 94-5V, Flammability
 3. FCC Part 15, Subpart B, Class B Limit
 4. BACnet Testing Laboratory (BTL) listed as BACnet Application Specific Controller (B-ASC)

APPLICATION CONTROLLER FOR PACKAGED ROOFTOP UNITS

- A. The Rooftop Unit (RTU) Application Controller shall be a microprocessor-based DDC controller which, through hardware or firmware design, controls specified equipment. The controller is not user programmable, but is customized for operation within the confines of the equipment it is designed to serve.
- B. The Application Controller shall be capable of operating as a stand-alone controller or as a member of a Building Automation System (BAS).
- C. When the Application Controller is operating as a member of a Building Automation System (BAS), the application controller shall operate as follows:
 - 1. Application Controller will receive operation mode commands from the BAS network controller. The BAS commands shall include but not be limited to the follow: Occupied Heat/Cool, Unoccupied Heat/Cool, Morning Warm-up, / Pre-cool, Occupied Bypass).
 - 2. Application Controller will provide equipment status parameters to the BAS through BACnet communication.
 - 3. Application Controller will operate as a stand-alone controller in the event of communication failure with the BAS.
 - 4. In case of communications failure stand-alone operation shall use default values or last known values for remote sensors read over the network such as outdoor air temperature.
- D. Software
 - 1. To meet the sequence of operation for each zone control, the controller shall use programs developed and tested by the controller manufacturer that are either factory loaded or customized with use of service tool native to the controller.
- E. Environment: Controller hardware shall be suitable for the anticipated ambient conditions.
 - 1. Storage: -55° to 203° F (-48° to 95° C) and 5 to 95% Rh, non-condensing.
 - 2. Operating: -40° to 158° F (-40 to 70° C) and 5 to 95% Rh, non-condensing.
 - 3. Controllers used indoors shall be mounted in a NEMA 1 enclosure at a minimum.
 - 4. Controllers used outdoors and/or in wet ambient shall be mounted within NEMA 4 type waterproof enclosures, and shall be rated for operation at -40° to 158° F -40° to 70° C.
- F. Controller Input/Output: The controller shall have on board capable of performing all functionality needed for the application. Controls provided by the equipment manufacture must supply the required I/O for the equipment.
 - 1. For flexibility in selection and replacement of valves, the controllers shall be capable of supporting all of the following output types; 0-10VDC, 0-5VDC, 4-20mA, Binary.
 - 2. For flexibility in selection and replacement of sensors, the controllers shall be capable of reading sensor input ranges of 0 to 10V, 0 to 20mA, Pulse counts, and 200 to 20Kohm.
- G. Serviceability – The controller shall provide the following in order to improve serviceability of the controller.
 - 1. Diagnostic LEDs shall indicate correct operation or failures/faults for all of the following: power, sensors, BACnet communications, and I/O communications bus.
 - 2. All binary output shall have LED's indicating the output state.
 - 3. All wiring connectors shall removable without the use of a tool.
 - 4. Software service tool connection through the following methods: direct cable connection to the controller, connection through another controller on BACnet link.
- H. Software Retention: All Zone Controller operating parameters, setpoints, BIOS, and sequence of operation code must be stored in non-volatile memory in order to maintain such information for months without power.
- I. Controller shall meet the following Agency Compliance:
 - 1. UL 916 PAZX, Open Energy Management Equipment
 - 2. UL 94-5V, Flammability

3. FCC Part 15, Subpart B, Class B Limit
4. BACnet Testing Laboratory (BTL) listed

VARIABLE AIR VOLUME TERMINAL UNIT CONTROLLERS

- A. General Description
 1. Variable Air Volume (VAV) controllers shall be microprocessor-based DDC controllers which, through hardware or firmware design, control specified equipment. They are typically not user programmable, but are configurable for operation of VAV terminal units.
 2. Variable Air Volume (VAV) controllers are controllers that operate equipment that control the space temperature of single zone.
- B. The VAV controller shall be capable of operating as a stand-alone controller or as a member of a Building Automation System (BAS).
- C. When the VAV controller is operating as a member of a Building Automation System (BAS), the application controller shall operate as follows:
 1. The VAV controller will receive operation mode commands from the BAS network controller. The BAS commands shall include but not be limited to the following: Occupied Heat/Cool, Unoccupied Heat/Cool, Morning Warm-up, / Pre-cool, Occupied Bypass).
 2. The VAV controller will provide equipment status parameters to the BAS through BACnet communication.
 3. The VAV controller will operate as a stand-alone controller in the event of communication failure with the BAS.
 4. In case of communications failure stand-alone operation shall use default values or last known values for remote sensors read over the network such as outdoor air temperature.
- D. Stand-Alone Operation: Each VAV Terminal Unit shall be controlled by a single controller and provide stand-alone control in the event that a BAS is not present.
- E. The VAV controller shall communicate to the building automation system via one of the following protocols: BACnet™ MS/TP, BACnet™ Zigbee or BACnet™ IP as defined in ANSI®/ASHRAE® Standard 135-2020.
 1. BACnet™ MS/TP
 - a. To allow maximum communications speed and co-existence with other controllers, the controller shall support at a minimum the following BACnet MS/TP manager baud rates: 9600, 19200, 38400, 76800.
 2. BACnet™ IP
 - a. BACnet IP controllers provide BACnet communications over Internet Protocol via Local Area Networks (LAN), an open standard building automation communication protocol that enables connections to other building automation systems and controllers
 3. BACnet™ Zigbee
 - a. VAV controller wireless communication interface shall self-form and self-heal to maintain operation in the event of network communication failure.
 - b. IEEE 802.15.4 radios to minimize risk of interference, reliability, and range.
 - c. Operating range shall be a minimum of 200 feet (6096 cm); open range shall be 2,500 feet (76200 cm) with less than 2% packet error rate.
 - d. To protect against harmful interference, certifications shall include Energy Management Equipment FCC CFR47, Section 15.247 & subpart E, Digital Modulation Transmission with no SAR (FCC ID: TPF-251701)
- F. Each VAV terminal unit shall use a space zone sensor(s) to measure the space condition it is serving.
- G. Software

-
1. To meet the sequence of operation for each zone control, the controller shall use programs developed and tested by the controller manufacturer that are either factory loaded or downloaded with service tool to the controller.
 2. For controlling ancillary devices and for flexibility to change the sequence of operation in the future, the controller shall be capable running custom programs written in a graphical programming language.
- H. Environment: Controller hardware shall be suitable for the anticipated ambient conditions.
1. Storage: -55° to 203° F (-48° to 95° C) and 5 to 95% Rh, non-condensing.
 2. Operating: -40° to 158° F (-40 to 70° C) and 5 to 95% Rh, non-condensing.
 3. Controllers used indoors shall be mounted in a NEMA 1 enclosure at a minimum.
 4. Controllers used outdoors and/or in wet ambient shall be mounted within NEMA 4 type waterproof enclosures, and shall be rated for operation at -40° to 158° F -40° to 70° C.
- I. Input/Output:
1. For flexibility in selection and replacement of valves, the controllers shall be capable of supporting all of the following valve control types 0-10VDC, 0-5VDC, 4-20mA, 24VAC floating point, 24VAC - 2 position (Normally Open or Normally Closed).
 2. For flexibility in selection and replacement of sensors, the controllers shall be capable of reading sensor input ranges of 0 to 10V, 0 to 20mA, and 200 to 20Kohm.
 3. For flexibility in selection and replacement of binary devices, the controller shall support dry and wetted (24VAC) binary inputs.
 4. For flexibility in selection and replacement devices, the controller shall have binary output which are able to drive at least 12VA each.
 5. For flexibility in selection and replacement of motors, the controller shall be capable of outputting 24VAC (binary output), DC voltage (0 to 10VDC minimum range) and PWM (in the 80 to 100 Hz range).
- J. Serviceability – The controller shall provide the following in order to improve serviceability of the controller.
1. Diagnostic LEDs shall indicate correct operation or failures/faults for all of the following: power, sensors, BACnet communications, and I/O communications bus.
 2. All binary output shall have LED's indicating the output state.
 3. All wiring connectors shall removable without the use of a tool.
 4. Software service tool connection through all of the following methods: direct cable connection to the controller, connection through another controller on BACnet link and through the controller's zone sensor.
 5. For safety purposes, the controller shall be capable of being powered by a portable computer for the purposes of configuration, programming, and testing programs so that this work can be accomplished with the power off to the equipment.
 6. Capabilities to temporarily override of BACnet point values with built-in time expiration in the controller.
 7. BACnet MAC Address shall be set using decimal (0-9) based rotary switches.
 - a. Configuration change shall not be made in a programming environment, but rather by a configuration page utilizing dropdown list, check boxes, and numeric boxes.
 8. For ease of troubleshooting, the Controller shall support BACnet data trend logging.
 - a. Trends shall be capable of being collected at a minimum sample rate of once every second.
 - b. Shall be capable of trending all BACnet points used by controller
 - c. Trends shall be capable of being scheduled or triggered
- K. Software Retention: All Zone Controller operating parameters, setpoints, BIOS, and sequence of operation code must be stored in non-volatile memory in order to maintain such information for months without power.

- L. Controller shall meet the following Agency Compliance:
 - 1. UL 916 PAZX, Open Energy Management Equipment
 - 2. UL 94-5V, Flammability
 - 3. FCC Part 15, Subpart B, Class B Limit
 - 4. AS/NZS CISPR 32:2016
 - 5. VCCI-CSPR 32:2016
 - 6. CAN ICES-003(B)/NMB-003(B)
 - 7. To ensure integration to the building automation system the controller must be BTL (BACnet Testing Lab) listed. The following BACnet profiles are in order of most functionality (B-BC) to least functionality (B-ASC).
 - a. BACnet Building Controller (B-BC)
 - b. BACnet Advance Applications Controller (B-AAC)
 - c. BACnet Application Specific Controller (B-ASC)

VARIABLE AIR SYSTEM - BYPASS DAMPER CONTROLLER

- 1. Software service tool connection through all of the following methods: direct cable connection to the controller, connection through another controller on BACnet link

INPUT/OUTPUT INTERFACE:

- A. Hardwired inputs and outputs may tie into the system through building, custom application, or ASCs.
- B. All input points and output points shall be protected such that shorting of the point to itself, to another point, or to ground will cause no damage to the controller. All input and output points shall be protected from voltage up to 24V of any duration, such that contact with this voltage will cause no damage to the controller.
- C. Binary inputs shall allow the monitoring of on/off signals from remote devices. The binary inputs shall provide a wetting current of at least 12 mA to be compatible with commonly available control devices and shall be protected against the effects of contact bounce and noise. Binary inputs shall sense "dry contact" closure without external power (other than that provided by the controller) being applied.
- D. Pulse accumulation input objects. This type of object shall conform to all the requirements of binary input objects and also accept up to 10 pulses per second for pulse accumulation.
- E. Analog inputs shall allow the monitoring of low voltage (0 to 10 VDC), current (4 to 20 mA), or resistance signals (thermistor, RTD). Analog inputs shall be compatible with and field configurable to commonly available sensing devices.
- F. Binary outputs shall provide for on/off operation or a pulsed low-voltage signal for pulse width modulation control. Binary outputs on building and custom application controllers shall have status lights. Outputs shall be selectable for either normally open or normally closed operation.
- G. Analog outputs shall provide a modulating signal for the control of end devices. Outputs shall provide either a 0 to 10VDC or a 4 to 20 mA signal as required to provide proper control of the output device. Analog outputs shall not exhibit a drift of greater than 0.4% of range per year.
- H. Tri-State Outputs. Provide tri-state outputs (two coordinated binary outputs) for control of three-point floating type electronic actuators without feedback. Use of three-point floating devices shall be limited to zone control and terminal unit control applications (VAV terminal units, duct-mounted heating coils, zone dampers, radiation, etc.). Control algorithms shall run the zone actuator to one end of its stroke once every 24 hours for verification of operator tracking.
- I. System Object Capacity. The system size shall be expandable to at least twice the number of input/ output objects required for this project. Additional controllers (along with associated devices and wiring) shall be all that is necessary to achieve this capacity requirement. The

operator interfaces installed for this project shall not require any hardware additions or software revisions in order to expand the system.

BAS – SOFTWARE SERVICE TOOLS

- A. Provide one copy of software service tool to enable controller back-up/restore, configuration, firmware update, diagnostics, and equipment status that is specifically compatible with the BACnet unit level controllers being installed as part of this project. This software shall be registered to the Owner at project completion. Manufacturer shall provide subscription to service tool for 5 years that entitles free software updates.

POWER SUPPLIES:

- A. Control transformers shall be UL listed. Furnish Class 2 current-limiting type or furnish overcurrent protection in both primary and secondary circuits for Class 2 service in accordance with NEC requirements. Limit connected loads to 80% of rated capacity.
 - 1. DC power supply output shall match output current and voltage requirements. Unit shall be full-wave rectifier type with output ripple of 5.0 mV maximum peak-to-peak. Regulation shall be 1.0% line and load combined, with 100-microsecond response time for 50% load changes. Unit shall have built-in overvoltage and overcurrent protection and shall be able to withstand a 150% current overload for at least three seconds without trip-out or failure.
 - a. Unit shall operate between 0°C and 50°C (32°F and 120°F). EM/RF shall meet FCC Class B and VDE 0871 for Class B and MIL-STD 810C for shock and vibration.
 - b. Line voltage units shall be UL recognized and CSA approved.

AUXILLARY CONTROL DEVICES:

- A. Motorized dampers, unless otherwise specified elsewhere, shall be as follows:
 - 1. Damper frames shall be 16 gauge galvanized sheet metal or 1/8" extruded aluminum with reinforced corner bracing.
 - 2. Damper blades shall not exceed 8" in width or 48" in length. Blades are to be suitable for medium velocity performance (2,000 fpm). Blades shall be not less than 16 gauge.
 - 3. Damper shaft bearings shall be as recommended by manufacturer for application.
 - 4. All blade edges and top and bottom of the frame shall be provided with compressible seals. Side seals shall be compressible stainless steel. The blade seals shall provide for a maximum leakage rate of 10 CFM per square foot at 2.5" w.c. differential pressure.
 - 5. All leakage testing and pressure ratings will be based on AMCA Publication 500.
 - 6. Individual damper sections shall not be larger than 48" x 60". Provide a minimum of one damper actuator per section.
- B. Control dampers shall be parallel or opposed blade types as scheduled on drawings.
- C. Electric damper/valve actuators
 - 1. The actuator shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the rotation of the actuator.
 - 2. Where shown, for power-failure/safety applications, an internal mechanical, spring return mechanism shall be built into the actuator housing.
 - 3. All rotary spring return actuators shall be capable of both clockwise or counter clockwise spring return operation. Linear actuators shall spring return to the retracted position.
 - 4. Proportional actuators shall accept a 0-10 VDC or 0-20 ma control signal and provide a 2-10 VDC or 4-20 ma operating range.
 - 5. All non-spring return actuators shall have an external manual gear release to allow manual positioning of the damper when the actuator is not powered. Spring return actuators with more than 60 inch (1524 mm)-lb. torque capacity shall have a manual crank for this purpose.

-
6. Actuators shall be provided with a conduit fitting and a minimum 1m electrical cable and shall be pre-wired to eliminate the necessity of opening the actuator housing to make electrical connections.
 7. Actuators shall be Underwriters Laboratories Standard 873 listed.
 8. Actuators shall be designed for a minimum of 60,000 full stroke cycles at the actuator's rated torque.
- D. Control Valves
1. Control valves shall be two-way or three-way type for two-position or modulating service as scheduled or shown.
 2. Close-off (differential) Pressure Rating: Valve actuator and trim shall be furnished to provide the following minimum close-off pressure ratings:
 - a. Water Valves:
 - 1) Two-way: 150% of total system (pump) head.
 - 2) Three-way: 300% of pressure differential between ports A and B at design flow or 100% of total system (pump) head.
 - b. Steam Valves: 150% of operating (inlet) pressure.
- E. Water Valves
1. Body and trim style and materials shall be in accordance with manufacturer's recommendations for design conditions and service shown, with equal percentage ports for modulating service.
 2. Sizing Criteria:
 - a. Two-position service: Line size.
 - b. Two-way modulating service: Pressure drop shall be equal to twice the pressure drop through heat exchanger (load), 50% of the pressure difference between supply and return mains, or 34.5 kPa 5 psi (34.47 kPa), whichever is greater.
 - c. Three-way modulating service: Pressure drop equal to twice the pressure drop through the coil exchanger (load), 34.5 kPa 5 psi (34.47 kPa) maximum.
 - d. Valves DN 15 1/2 inch (12.7 mm) through DN 50 (2 inch (50.8 mm)) shall be bronze body or cast brass ANSI Class 250, spring-loaded, PTFE packing, quick opening for two-position service. Two-way valves to have replaceable composition disc or stainless steel ball.
 - e. Valves DN 65 (2 1/2 inch (12.7 mm)) and larger shall be cast iron ANSI Class 125 with guided plug and PTFE packing.
 3. Water valves shall fail normally open or closed, as scheduled on plans, or as follows:
 - a. Water zone valves—normally open preferred
 - b. Heating coils in air handlers - normally open
 - c. Chilled-water control valves - normally closed
 - d. Other applications—as scheduled or as required by sequences of operation
 4. Zone valves shall be sized to meet the control application and they shall maintain their last position in the event of a power failure.
- F. Steam Valves
1. Body and trim materials shall be in accordance with manufacturer's recommendations for design conditions and service with linear ports for modulating service.
 2. Sizing Criteria:
 - a. Two-position service: pressure drop 10% to 20% of inlet psig
 - b. Modulating service: 100 kPa 15 psig (103.42 kPa) or less; pressure drop 80% of inlet psig
 - c. Modulating service: 101 to 350 kPa (16 to 50 psig (344.74 kPa); pressure drop 50% of inlet psig
 - d. Modulating service: over 350 kPa 50 psig (344.74 kPa); pressure drop as scheduled on plans

G. Binary Temperature Devices

1. Low-voltage space thermostat shall be 24 V, bimetal-operated, mercury-switch type, with either adjustable or fixed anticipation heater, concealed setpoint adjustment, 13°C to 30°C (55°F to 85°F) setpoint range, 1°C (2°F) maximum differential, and vented ABS plastic cover.
2. Line-voltage space thermostat shall be bimetal-actuated, open contact type, or bellows-actuated, enclosed, snap-switch type or equivalent solid-state type, with heat anticipator, UL listed for electrical rating, concealed setpoint adjustment, 13°C to 30°C (55°F to 85°F) setpoint range, 1°C (2°F) maximum differential, and vented ABS plastic cover.
3. Low-limit thermostats. Low-limit airstream thermostats shall be UL listed, vapor pressure type, with an element of 6.56 yard (6 meter) (20 ft) minimum length. Element shall respond to the lowest temperature sensed by any 0.98 feet (30 cm) (1 ft) section. The low-limit thermostat shall be manual reset only.

H. Wired Temperature Sensors

1. Temperature sensors shall be RTD or thermistor.
2. Duct sensors shall be single point or averaging as shown. Averaging sensors shall be a minimum of 1.64 yard (1.5 meter) (5 ft) in length per 1 m² 102 feet (3108.96 cm) of duct cross section.
3. Immersion sensors shall be provided with a separable stainless steel well. Pressure rating of well is to be consistent with the system pressure in which it is to be installed. The well must withstand the flow velocities in the pipe.
4. Space sensors located in classrooms shall be flat plate Stainless steel sensing only.
5. Cafeteria, GYM, Admin Area, and other common spaces shall be equipped with setpoint adjustment, override switch, display, and/or communication port as shown on plans.
 - a. Provide lockable plastic clear cover.
6. Provide matched temperature sensors for differential temperature measurement.

I. Wired Humidity Sensors

1. Duct and room sensors shall have a sensing range of 20% to 80%.
2. Duct sensors shall be provided with a sampling chamber.

J. Static Pressure Sensors

1. Sensor shall have linear output signal. Zero and span shall be field-adjustable.
2. Sensor sensing elements shall withstand continuous operating conditions plus or minus 50% greater than calibrated span without damage.

K. Low Limit Thermostats

1. Safety low limit thermostats shall be vapor pressure type with an element 6m 20 ft minimum length. Element shall respond to the lowest temperature sensed by any one foot section.
2. Low limit shall be manual reset only.

WIRING AND RACEWAYS:

- A. General: Provide copper wiring, plenum cable, and raceways as specified in the applicable sections of this specification.
- B. All insulated wire to be copper conductors, UL labeled for 90°C (194°F) minimum service.
- C. Fiber Optic Cable. Optical cables shall be duplex 35.43 inch (900 mm) tight-buffer construction designed for intra-building environments. The sheath shall be UL Listed OFNP in accordance with NEC Article 770. The optical fiber shall meet the requirements of FDDI, ANSI X3T9.5 PMD for 62.5/125 µm.

PART 3 EXECUTION

29.01 EXAMINATION:

- A. The Contract Documents shall be thoroughly examined for coordination of control devices, their installation, wiring, and commissioning. Coordinate and review mechanical equipment specifications, locations, and identify any discrepancies, conflicts, or omissions that shall be reported to the Architect/Engineer for resolution before rough-in work is started.
- B. The BAS manufacturer shall inspect the jobsite in order to verify that control equipment can be installed as required, and any discrepancies, conflicts, or omissions shall be reported to the Architect/Engineer for resolution before rough-in work is started.

PROTECTION:

- A. The BAS installation contractor shall protect all work and material from damage by their work or personnel, and shall be liable for all damage thus caused.
- B. The BAS manufacturer shall be responsible for their work and equipment until final inspection, testing, and acceptance. The BAS installing contractor shall protect their work against theft or damage, and shall carefully store material and equipment received on site that is not immediately installed. The Contractor shall close all open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

COORDINATION:

- A. Site
 - 1. Where the mechanical work will be installed in close proximity to, or will interfere with, work of other trades, the contractor shall assist in working out space conditions to make a satisfactory adjustment. If the contractor installs his/her work before coordinating with other trades, so as to cause any interference with work of other trades, the contractor shall make the necessary changes in his/her work to correct the condition without extra charge.
 - 2. Coordinate and schedule work with all other work in the same area, or with work that is dependent upon other work, to facilitate mutual progress.
- B. Submittals. Refer to the "Submittals," section of this specification for requirements.
- C. Test and Balance
 - 1. The contractor shall furnish a single set of all tools necessary to interface to the control system for test and balance purposes.
 - 2. The contractor shall provide training in the use of these tools. This training will be planned for a duration of 4 hours.
 - 3. In addition, the contractor shall provide a qualified technician to assist in the test and balance process, until the first 20 terminal units are balanced.
 - 4. The tools used during the test and balance process shall be returned to the contractor at the completion of the testing and balancing.
- D. Life Safety
 - 1. Duct smoke detectors required for air handler shutdown shall be supplied under Section 26100 of this specification. The contractor shall interlock smoke detectors to air handlers for shutdown as described in the Sequences of Operation for this project.
 - 2. Smoke dampers and actuators required for duct smoke isolation are provided under Section 26100. The contractor shall interlock these dampers to the air handlers as described in the Sequences of Operation for this project as applicable.
 - 3. Fire/smoke dampers and actuators required for fire rated walls are provided under another Section 26100. Control of these dampers shall be by 26100
- E. Coordination with Controls Specified in Other Sections or Divisions. Other sections and/or divisions of this specification include controls and control devices that are to be part of or

interfaced to the control system specified in this section. These controls shall be integrated into the system and coordinated by the contractor as follows:

1. All communication media and equipment shall be provided as specified in the "Communication" section of this specification.
2. Each supplier of a controls product is responsible for the configuration, programming, start-up, and testing of that product to meet the sequences of operation described in this section.
3. The Contractor shall coordinate and resolve any incompatibility issues that arise between the control products provided under this section and those provided under other sections or divisions of this specification.

GENERAL WORKMANSHIP:

- A. Install equipment, piping, wiring/conduit, parallel to building lines (i.e. horizontal, vertical, and parallel to walls) wherever possible.
- B. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.
- C. Install all equipment in readily accessible locations as defined by National Electric Code (NEC). Control panels shall be attached to structural walls or properly supported in a free-standing configuration, unless mounted in equipment enclosure specifically designed for that purpose. Panels shall be mounted to allow for unobstructed access for service.
- D. Verify integrity of all control wiring to ensure continuity and freedom from shorts and grounds prior to commencing the startup and commissioning procedures.
- E. All control device installation and wiring shall comply with Contract Documents, acceptable industry specifications, and industry standards for performance, reliability, and compatibility. Installation and wiring shall be executed in strict adherence to local codes and standard practices referenced in Contract Documents.

FIELD QUALITY CONTROL:

- A. All work, materials, and equipment shall comply with the rules and regulations of applicable local, state, and federal codes and ordinances as identified in Contract Documents.
- B. BAS manufacturer shall continually monitor the field installation for building code compliance and quality of workmanship. All visible piping and or wiring runs shall be installed parallel to building lines and properly supported.
- C. BAS installing Contractor(s) shall arrange for field inspections by local and/or state authorities having jurisdiction over the work.

COMMUNICATION WIRING:

- A. All cabling shall be installed in a neat and workmanlike manner. Follow manufacturer's installation recommendations for all communication cabling.
- B. Do not install communication wiring in raceway and enclosures containing Class 1 or other Class 2 wiring.
- C. Maximum pulling, tension, and bend radius for cable installation, as specified by the cable manufacturer shall not be exceeded during installation.
- D. Contractor shall verify the integrity of the entire network following cable installation. Use appropriate test measures for each particular cable.
- E. When a cable enters or exits a building, a lighting arrestor must be installed between the line and ground.
- F. All runs of communication wiring shall be unspliced length when the length is commercially available.
- G. All communication wiring shall be labeled to indicate origin and destination.

INSTALLATION OF SENSORS:

- A. Sensors required for mechanical equipment operation shall be factory installed and wired as specified in mechanical equipment specifications. BAS manufacturer shall be responsible for coordinating these control devices and ensuring the sequence of operations will be met. Installation and wiring shall be in accordance with the BAS manufacturer's recommendations.
- B. Sensors that require field mounting shall meet the BAS manufacturer's recommendations and be coordinated with the mechanical equipment they will be associated.
- C. Mount sensors rigidly and adequately for the environment the sensor will operate.
- D. Room temperature sensors shall be installed on concealed junction boxes properly supported by the block wall framing. For installation in dry wall ceilings, the low voltage sensor wiring can be installed exposed and must meet applicable National and Local Electrical Codes.
- E. All wires attached to wall mounted sensors shall be sealed off to prevent air from transmitting in the associated conduit and affecting the room sensor readings.
- F. Install duct static pressure tap with tube end facing directly down-stream of air flow.
- G. Install space static pressure sensor with static sensing probe applicable for space installation where applicable.
- H. Sensors used in mixing plenums, and hot and cold decks shall be of the averaging type. Averaging sensors shall be installed in a serpentine manner horizontally across duct. Each bend shall be supported with a capillary clip.
- I. All pipe mounted temperature sensors shall be installed in matched thermowells. Install all liquid temperature sensors with heat conducting fluid in thermal wells for adequate thermal conductance.
- J. Wiring for space sensors shall be concealed in building drywall. EMT conduit is acceptable within mechanical equipment and service rooms.
- K. Install outdoor air temperature sensors on north wall complete with sun shield at manufacturer's recommended location and coordinated with Engineer.

FLOW SWITCH INSTALLATION:

- A. Coordinate installation of flow switch with Mechanical Contractor who will be responsible for installing a thread o let in steel piping applications. Copper pipe applications will require the use CxCxF Tee, and no pipe extensions or substitutions will be allowed.
- B. Mount a minimum of 5 pipe diameters upstream and 5 pipe diameters downstream, or two feet, whichever is greater, from pipe fittings and other inline potential obstructions.
- C. Install in accordance with manufacturers' instructions, which will require proper flow direction, horizontal alignment with flow switch mounting on the top of pipe.

WARNING LABELS:

- A. Permanent warning labels shall be affixed to all equipment that can be automatically started by the BAS system.
- B. Permanent warning labels shall be affixed to all motor starters and all control panels that are connected to multiple power sources utilizing separate disconnects.

IDENTIFICATION OF HARDWARE AND WIRING:

- A. All field wiring and cabling, including that within factory mounted, and wired control panels and devices for mechanical equipment, shall be labeled at each end within 2" of termination with a cable identifier and other descriptive information for troubleshooting, maintenance, and service purposes. BAS manufacturer to coordinate this labeling requirement with mechanical equipment manufacturer as it relates to controls.

- B. Permanently label or code each point of field terminal strips to show the instrument or item served and correlate them to the BAS design drawings.
- C. Identify control panels with minimum 1-cm letters on laminated plastic nameplates.
- D. Identifiers shall match record documents. All plug-in components shall be labeled such that removal of the component does not remove the label.

CONTROLLERS:

- A. Provide a separate DDC Controller for individual HVAC mechanical equipment. BAS manufacturer shall furnish and coordinate DDC controllers and control devices and ensure that installation and wiring adhere to BAS manufacturer's design recommendations. For those mechanical equipment units that do not have factory installed controls specified, the BAS manufacturer shall field mount controls and coordinate all installation and termination information to ensure the specified sequence of operations are met.
- B. Building Controllers and Custom Application Controllers shall be selected to provide a minimum of 15% spare I/O point capacity for each point type (analog or digital) found at each location. If input points are not universal, 15% of each type is required. If outputs are not universal, 15% of each type is required. A minimum of one spare is required for each type of point used in each controller.
 - 1. Future use of spare I/O point capacity shall require providing the field instrument and control device, field wiring, engineering, programming, and commissioning. No additional Controller boards or point modules shall be required to implement use of these spare points.

PROGRAMMING:

- A. Provide sufficient internal memory for all controllers to ensure specified sequence of operations, alarming, trending, and reporting requirements are achieved. BAS manufacturer shall provide a minimum of 25% spare memory capacity for future use.
- B. Point Naming: System point names shall be modular in design, allowing easy operator interface without the use of a written point index.
- C. Software Programming
 - 1. Provide programming for individual mechanical systems to achieve all aspects of the sequence of operation specified. It is the BAS manufacturer's responsibility to ensure all mechanical equipment functions and operates as specified in sequence of operations. Provide sufficient programming comments in controller application software to clearly describe each section of the program. The comment statements shall reflect the language used in the sequence of operations.
- D. BAS Operator's Interface
 - 1. When Operator Workstation is specified, provide color graphics for each piece of mechanical equipment depicting sufficient I/O to monitor and troubleshoot operation. Operator color graphics shall include Chiller Plant, Cooling Tower System, Boiler Plant, Air Handling Units, Rooftop Units, VAV Terminal Boxes, Fan Coil Units, Unit Ventilators, Heat Exchangers, Exhaust Fans, etc. These standard graphics shall depict all points dynamically as specified in the points list and/or indicated in sequence of operation.
 - 2. The BAS manufacturer shall provide all the labor necessary to install, initialize, start up, and trouble-shoot all operator interface software and their functions as described in this section. This includes any operating system software, the operator interface data base, and any third party software installation and integration required for successful operation of the operator interface.
 - 3. As part of this execution phase, the BAS manufacturer shall perform a complete test of the operator interface.

CONTROL SYSTEM CHECKOUT AND TESTING:

- A. Start-up testing. All testing in this section shall be performed by the contractor and shall make up part of the necessary verification of an operating control system. This testing shall be completed before the owner's representative is notified of the system demonstration.
 - 1. The contractor shall furnish all labor and test apparatus required to calibrate and prepare for service all of the instruments, controls, and accessory equipment furnished under this specification.
 - 2. Verify that all control wiring is properly connected and free of all shorts and ground faults. Verify that terminations are tight.
 - 3. Enable the control systems and verify calibration of all input devices individually. Perform calibration procedures according to manufacturer's recommendations.
 - 4. Verify all binary output devices (relays, solenoid valves, two-position actuators and control valves, magnetic starter, etc.) operate properly and normal positions are correct.
 - 5. Verify all analog output devices (I/Ps, actuators, etc) are functional, that start and span are correct, and that direction and normal positions are correct. The contractor shall check all control valves and automatic dampers to ensure proper action and closure. The contractor shall make any necessary adjustments to valve stem and damper blade travel.
 - 6. Verify the system operation adheres to the sequences of operation. Simulate and observe all modes of operation by overriding and varying inputs and schedules. Tune all DDC loops and optimal start/stop routines.
 - 7. Alarms and Interlocks
 - a. Check each alarm separately by including an appropriate signal at a value that will trip the alarm.
 - b. Interlocks shall be tripped using field contacts to check the logic, as well as to ensure that the fail-safe condition for all actuators is in the proper direction.
 - c. Interlock actions shall be tested by simulating alarm conditions to check the initiating value of the variable and interlock action.

CLEANING:

- A. The BAS manufacturer's installing contractor(s) shall clean up all debris resulting from their installation activities on a daily basis. The installation contractors shall remove all cartons, containers, crates, etc. under his control as soon as their contents have been removed. Waste shall be collected and placed in a location designated by the Owner, Construction Manager, General Contractor, and/or Mechanical Contractor.
- B. At the completion of work in any area, the installation contractor shall clean all of their work, equipment, etc., making it free from dust, dirt and debris.
- C. At the completion of work, all equipment furnished under this Section shall be checked for paint damage. Any factory finished paint that has been damaged shall be repaired to match the adjacent areas. Any metal cabinet or enclosure that has been deformed shall be replaced with new material and repainted to match the adjacent areas.

TRAINING:

- A. Provide minimum of (4) hours of operator training throughout the contract period. The training will be provided for personnel designated by the Owner.
- B. These objectives will be divided into logical groupings; participants may attend one or more of these, depending on level of knowledge required:
 - 1. Day-to-day BAS Operators
 - 2. BAS Troubleshooting & Maintenance

END OF SECTION

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Low pressure duct.
- B. Duct pressure testing.

1.02 RELATED WORK

- A. Section 09900 - Painting: Weld priming, weather resistant, paint or coating.
- B. Section 15140 - Supports and Anchors: Sleeves.
- C. Section 15250 - Mechanical Insulation.
- D. Section 15910 - Duct Accessories.
- E. Section 15990 - Testing, Adjusting and Balancing.
- F. Section 013300 Submittals.
- G. Section 01524 Construction Waste Management
- H. Section 01352 LEED Requirements
- I. Section 01611 Environmental Management
- J. Section 01570 Pollution Prevention and Control

1.03 REFERENCES

- A. ASHRAE - Handbook 1993 Fundamentals; Chapter 32 - Duct Design.
- B. ASHRAE - Handbook 1992 HVAC Systems and Equipment; Chapter 16 - Duct Construction.
- C. ASTM A 90 - Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles.
- D. ASTM A 525 - General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.
- E. ASTM A 527 - Steel Sheet, Zinc-Coated (Galvanized) by Hot-Dip Process, Lock Forming Quality.
- F. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.
- G. NFPA 90B - Installation of Warm Air Heating and Air Conditioning Systems.
- H. SMACNA - Low Pressure Duct Construction Standards.
- I. UL 181 - Factory-Made Air Ducts and Connectors.
- J. ASTM A 167 - Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
- K. NFPA 96 - Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors from Commercial Cooling Equipment.

1.04 DEFINITIONS

- A. Duct sizes shown are net inside clear dimensions. Duct shall be externally insulated. Where offsets or transitions are required, the duct shall maintain the equivalent diameter based on hydraulic diameter and rectangular duct size for equal flow, velocity and pressure drop as calculated by Huebscher formulae #30 and/or 31 inch (787.4 mm) ASHRAE Duct Design Fundamentals Handbook and Figure 5 Friction Chart for round duct.
- B. Low Pressure: Three pressure classifications: 1/2 inch (12.7 mm) WG positive or negative static pressure and velocities less than 2,000 fpm; 1 inch (25.4 mm) WG positive or negative static pressure and velocities less than 2,500 fpm, and 2 inch (50.8 mm) WG positive or negative

static pressure and velocities less than 2,500 fpm. All ducts shall be sealed as specified, independent of SMACNA pressure class.

1.05 REFERENCE STANDARDS

- A. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2024.
- B. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems; 2024.
- C. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations; 2024.
- D. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors; Current Edition, Including All Revisions.

1.06 SUBMITTALS

- A. Refer to other applicable sections for additional coordination drawings, duct shop drawings and product data and conform to provisions of Division 1.
- B. Indicate duct fittings, particulars such as gages, sizes, welds, and configuration prior to start of work.
- C. The Contract Documents are schematic in nature and are to be used only for design intent. The Contractor shall prepare coordination and sheet metal shop drawings, fully detailed and drawn to scale, indicating all architectural partitions, structural conditions, all plumbing pipe and light fixtures co-ordinations, and all offsets and transitions as required to permit the duct to fit in the space allocated and built and show all bottom of duct elevations. All duct revisions required as a result of the Contractor not preparing fully detailed shop drawings will be performed at no additional cost to the Owner.
- D. Sheet metal ductwork "shop" drawings shall be made after actual job measurements are obtained. Sheet metal ductwork drawings shall indicate the coordination of the Contractor with sprinkler piping and other mechanical and electrical services installed under Division 15 and 16. These "Shop Drawings" shall be submitted for review as specified. Ductwork joint, connection, ductwork "shop" drawing submittal. Details shall be indexed and index number shall appear on ductwork "shop drawing" at its point of use.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site under provisions of Division 1.
- B. Store and protect products under provisions of Division 1.
- C. Protect duct from contamination by dirt, dust or rain by covering openings; do not store duct in open on site.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Armco - "Zinc-Grip".
- B. Flex-master.
- C. Substitutions: Under provisions of Division 1.

2.02 DUCTWORK GENERAL

- A. All ductwork indicated on the Drawings, specified or required for the air conditioning and ventilating systems shall be of materials as hereinafter specified unless indicated otherwise. All air distribution ductwork shall be fabricated, erected, supported, etc., in accordance with all applicable standards of SMACNA Duct Manuals where such standards do not conflict with NFPA 90A and where class of construction equals or exceeds that noted herein. All exhaust

ductwork including toilet room exhausts shall be constructed and leak tested as specified for medium pressure supply ducts at negative pressure.

- B. All ductwork shown on the Drawings, specified or required for the heating, ventilating and air conditioning systems shall be constructed and erected in a first class workmanlike manner. The work shall be guaranteed for a period of one (1) year from and after the date of acceptance of the job against noise, chatter, whistling, vibration, and free from pulsation under all conditions of operation. After the system is in operation, should these defects occur, they shall be corrected as directed by the Architect.
- C. All duct sizes shown on the Drawings are air stream sizes. Allowance shall be made for internal lining where required, to provide the required cross sectional area.
- D. All holes in ducts for damper rods and other necessary devices shall be either drilled or machine punched (not pin punched), and shall not be any larger than necessary. All duct openings shall be provided with sheet metal caps if the openings are to be left unconnected for any length of time.
- E. Except for special ducts specified elsewhere herein, all sheet metal used on the project shall be constructed from prime galvanized steel sheets and/or coils up to 60" in width. Each sheet shall be stenciled with manufacturer's name and gauge. Coils of sheet steel shall be stenciled throughout on ten foot (10') centers with manufacturer's name and must be visible after duct is installed. Sheet metal must conform to SMACNA sheet metal tolerances as outlined in SMACNA's "HVAC Duct Construction Standards."
- F. Where ducts, exposed to view (including equipment rooms), pass through walls, floors or ceilings, furnish and install sheet metal collars around the duct.

2.03 MATERIALS

- A. General: Non-combustible and conforming to requirements for Class 1 air duct materials, or UL 181.
- B. Steel Ducts: ASTM A525 galvanized steel sheet, lock-forming quality, having zinc coating of 1.25 oz per sq. ft. for each side in conformance with ASTM A90. Minimum gauge for all duct shall be 26 gauge (0.019").
- C. Flexible Round Ducts:
 - 1. Low pressure: Interlocking spiral wire of galvanized steel or aluminum construction with flexible trilaminate inner fabric rated to 6 inches (152.4 mm) WG positive and 1 inches (25.4 mm) WG negative for low pressure ducts, insulated with 1" thick fiberglass insulation and reinforced metalized outer vapor barrier; Flexmaster type 5-m insulated or equal, NFPA 90A and U.L. 181 class 1 listed;
- D. Fasteners: Rivets, bolts, or sheet metal screws.
- E. Sealant: Non-hardening, water resistant, fire resistive, compatible with mating materials; liquid used alone or with tape, or heavy mastic.
- F. Hanger Rod: Steel, galvanized; continuously threaded.

2.04 LOW PRESSURE DUCT

- A. The scope of low pressure ductwork is defined as all ductwork downstream of terminal units, and all exhaust ductwork downstream of fans. Construction of all low pressure duct shall be in accordance with Low Velocity Duct Construction Standards as published by Sheet Metal and Air Conditioning Contractors National Association (SMACNA) and shall be sealed and tested at 3" static with the same test procedures as required by SMACNA.
- B. Spiral wound round duct shall be as manufactured by United McGill Sheet Metal Company or approved equal.

- C. The metal gauges listed in the latest SMACNA HVAC Duct Construction Standards for Metal and Flexible Duct are the minimum which shall be used for this project. It shall be noted that the Contractor is responsible that the metal gauge selected is heavy enough to withstand the physical abuse of the installation.
- D. Elbows shall be radius type and have a centerline radius of 1-1/2 times the duct diameter or width. Elbows in round ducts may be smooth radius as described above or 5-piece 90 degree elbows and 3-piece 45 degree elbows. Joints in round ducts shall be slip type with a minimum of three sheet metal screws. Joints in sectional elbows shall be sealed as specified for duct sealing.
- E. SEALANT: All ductwork (except welded exhaust duct) shall be sealed with either "MP" (Multi-Purpose), Hardcast "Iron-grip 601", Polymer Adhesive "Airseal #11", or "United Duct Seal" (United McGill Corp.) water base, latex or acrylic type sealant. Note that, except as noted, oil or solvent based sealants are specifically prohibited for use on this project. For exterior applications, "Uni-Weather" (United McGill Corp.) neoprene based sealant shall be used. No other sealants may be used. All seams and joints in shop and field fabricated ductwork shall be sealed by applying one layer of sealant, then immediately spanning the joint with a single layer of 3" wide open weave fiberglass tape. Sufficient additional sealant shall then be applied to completely imbed the cloth. All sealants shall be UL rated at no more than flame spread of 5 and smoke developed of 0. At contractor's option Hardcast 1602 sealant tape may be used in lap joints and flat seams.
- F. Fabricate and support in accordance with SMACNA Low Pressure Duct Construction Standards and ASHRAE handbooks, except as indicated. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated, except that all duct joints and longitudinal seams for all SMACNA classes of duct shall be sealed with U.L. Listed Hardcast DT-tape and sealant FTA-20.
- G. Size round ducts installed in place of rectangular ducts in accordance with ASHRAE table of equivalent rectangular and round ducts. No variation of duct configuration or sizes permitted except by approved shop drawings.
- H. Construct tees, offsets, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows are used, provide single thickness turning vanes for duct velocities up to 1500 fpm and for higher duct velocities, provide airfoil turning vanes.
- I. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible. Divergence upstream of equipment shall not exceed 30 degrees; convergence downstream shall not exceed 45 degrees.
- J. Use crimp joints with bead for joining round duct sizes 6 inch (152.4 mm) smaller with crimp in direction of air flow.
- K. Use double nuts and lock washers on threaded rod supports.

PART 3 EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

- A. Obtain manufacturer's inspection and acceptance of fabrication and installation of duct at beginning of installation.
- B. Provide openings in duct where required to accommodate thermometers and controllers. Provide pilot tube openings where required for testing of systems, complete with metal well and closure device to ensure against air leakage. Where openings are provided in insulated duct, install insulation material inside a metal ring.

-
- C. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
 - D. Connect fan coil units to low pressure OA intake ducts with short length of flexible duct. Hold in place with corrosion resistant clamp or strap.
 - E. Connect air distribution devices to low pressure ducts with 6 feet (182.88 cm) maximum, 4 feet (121.92 cm) minimum, length of flexible duct. Hold in place with corrosion resistant strap or clamp.
 - F. During construction provide temporary closures of metal or taped polyethylene on open duct to prevent construction dust from entering duct system.
 - G. The interior surface of all duct shall be smooth. No sheet metal parts, tabs, angles, or anything else may project into the ducts for any reason, except as specified to be so. All seams and joints shall be external.
 - H. Where ducts pass through floors, provide structural angles for duct support. Where ducts pass through walls in exposed areas, install suitable sheet metal escutcheons.
 - I. All angles shall be carried around all four sides of the duct or group of ducts. Angles shall overlap corners and be welded or riveted.
 - J. All ducts shall be fabricated in a manner to prevent the seams or joints being cut for the installation of air distribution devices.
 - K. All rectangular duct located exposed on roof shall have top horizontal surface "crowned or sloped" to prevent water from ponding. Ref: Insulation for additional requirements.
 - L. Provide all new round flex duct maximum length 2'-0", for extension use round sheet metal duct externally insulated with 1-1/2" thick, 1.5 p.c.f. Density fiberglass insulation with "F-S-K-L" (foil-skrim-kraft-laminate) vapor barrier.
 - M. Provide round spin-in fittings with locking quadrant butterfly volume dampers for all round duct connections to rectangular ducts. Spin-in and flex duct shall be same size as air distribution device neck diameter. Secure flex duct to spin-in and air distribution device neck with stainless steel worm gear clamps and seal vapor barrier. Suspend flex duct from structure above; round and flexible duct shall be as detailed by SMACNA in section iii round, oval and flexible duct. Round duct seams shall be type RL-1 spiral seam or seam type RL-5 grooved seam flat pipe lock constructed in accordance with SMACNA figure 3-1; flexible duct supports shall be constructed and installed in accordance with SMACNA figures 3-9 and 3-10.
 - N. Duct dimensions shown are net clear Internal Dimensions; allowance must be made for 1-1/2" thick external insulation as specified; all rectangular and round supply air, return air, outside air and exhaust air duct shall be galvanized sheet metal.
 - O. Provide duct test wells at all locations required for testing, adjusting balancing, and temperature measuring.
 - P. All duct shall be mounted tight to underside of structure and shall be top level with bottom and side transitions only, except that allowance shall be made for duct to be externally insulated, which shall be mounted 3" below structural beams and joists or other obstruction to allow installation of the external duct insulation. Some ducts may require the use of "ESS"-drive joints or flat seams to allow crossing of duct or installation of other equipment or piping. Raise existing duct where required to allow installation of other duct or equipment; use 45 degree radius elbows (center line radius = 1.5 times duct height) to offset.
 - Q. Typical supply, return and exhaust duct shall be as detailed by SMACNA in Section II fittings and other construction. All 90 degree elbows shall be constructed in accordance with SMACNA figure 2-2, style RE-1 radius elbow (center line radius = 1.5 times duct height or width), space

permitting or style RE-2 square throat with turning vanes (provide duct access panel up stream of turning vanes for cleaning purposes).

- R. Turning vanes shall be installed in accordance with figure 2.3; single wall type with trailing edge for duct velocities up to 1500 fpm and double wall turning vanes above 1500 fpm duct velocity.
- S. Parallel flow branches shall be constructed in accordance with figure 2-7. Rectangular duct branch connections shall be expanded 45 degree entry type and round branch duct connections shall be spin-in type in accordance with figure 2-8 and offsets and transitions shall be in accordance with figure 2-9.
- T. Duct access doors shall be constructed in accordance with figure 2-12 and shall have a frame type 3, position 3 hinge with a type 2 locking handle; single and multi-blade volume dampers shall be in accordance with figures 2-14 and 2-15 respectively and shall have operator extensions when provided on externally insulated ducts; air distribution device connections shall be in accordance with figure 2-16 and ceiling diffuser branch ducts shall be in accordance with figure 2-17.
- U. Rectangular duct connections at all air moving equipment shall be flexible neoprene fabric and installed in accordance with figure 2-19.
- V. Seal all non-welded duct joints of all SMACNA pressure classes with Hard-cast DT-cotton tape and duct sealer FTA-20 for indoor duct and duct sealer FTA-50 for exterior duct.

3.02 DUCT APPLICATION SCHEDULE

- A. AIR SYSTEM MATERIAL
- B. Low Pressure Supply or return Galvanized Steel
- C. Return and Relief Galvanized Steel
- D. General Exhaust Galvanized Steel
- E. Outside Air Intake Galvanized Steel
- F. Kitchen Exhaust 16 Gauge Stainless Steel (welded)
- G. Fume Hood Exhaust 16 Gauge Stainless Steel (welded)
- H. Science Wet Lab Supply and Return 16 Gauge Stainless Steel (welded)
- I. Shower Area Supply and Return 16 Gauge Stainless Steel (welded)

3.03 DUCT HANGERS AND SUPPORTS

- A. All ducts shall be properly suspended or supported from the building structure. Hangers shall be galvanized steel straps or hot-dipped galvanized rod with threads pointed after installation. Strap hanger shall be attached to the bottom of the duct. The spacing, size and installation of hangers shall be in accordance with the recommendations of SMACNA, latest edition.
- B. All duct risers shall be supported by angles or channels secured to the sides of the ducts at each floor with sheet metal screws or rivets. The floor supports may also be secured to ducts by rods, angles or flat bar to the duct joint or reinforcing. Miscellaneous steel supports for duct risers shall be provided under this Division.

3.04 ADJUSTING AND CLEANING

- A. Clean duct system and force air at high velocity through duct to remove accumulated dust. To obtain sufficient air, clean half the system at a time. Protect equipment which may be harmed by excessive dirt with temporary filters, or bypass during cleaning.

END OF SECTION

PART 1 GENERAL

1.01 WORK INCLUDED

- A. HVAC air distribution ductwork.
- B. Duct pressure testing.

1.02 RELATED WORK

- A. Section 09900 - Painting: Weld priming, weather resistant, paint or coating.
- B. Section 15140 - Supports and Anchors: Sleeves.
- C. Section 15250 - Mechanical Insulation.
- D. Section 15910 - Duct Accessories.
- E. Section 15990 - Testing, Adjusting and Balancing.
- F. Section 013300 Submittals.

1.03 REFERENCES

- A. ASHRAE – Fundamentals Handbook, Latest Version; Duct Design.
- B. ASHRAE - HVAC Systems and Equipment Handbook, Latest Version; Duct Construction.
- C. ASTM A 90 - Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles.
- D. ASTM A 525 - General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.
- E. ASTM A 527 - Steel Sheet, Zinc-Coated (Galvanized) by Hot-Dip Process, Lock Forming Quality.
- F. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.
- G. NFPA 90B - Installation of Warm Air Heating and Air Conditioning Systems.
- H. SMACNA - Duct Construction Standards.
- I. UL 181 - Factory-Made Air Ducts and Connectors.
- J. ASTM A 167 - Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
- K. NFPA 96 - Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors from Commercial Cooling Equipment.

1.04 DEFINITIONS

- A. WG - Water Gauge
- B. Static Pressure - Total air pressure less velocity air pressure. Static pressure type is defines as positive or negative pressures relative to standard atmospheric conditions unless denoted otherwise.
- C. Duct Size - Net inside clear dimensions after insulation. Where offsets or transitions are required, the duct shall maintain the equivalent area based on hydraulic diameter and rectangular duct size for equal flow, velocity and pressure drop as calculated by Huebscher Formula #30 and/or #31 inch (787.4 mm) ASHRAE Duct Design Fundamentals Handbook and associated Friction Chart for round duct.
- D. Pressure Classification - SMACNA standard classification system for ductwork applications not exceeding listed static pressure and velocity services. SMACNA standard static pressure classes are defined as follows:

Pressure Class	Operating Pressure (WG)	Pressure Type	Max Velocity (fpm)	Seal Class
1/2	< 1/2"	Any	< 2,000	C
1	1/2" to 1"	Any	< 2,500	C
2	>1" to 2"	Any	< 2,500	B (note 1)
3	>2" to 3"	Any	<4,000	B
4	>3" to 4"	Positive Only	<4,000	A
6	>4" to 6"	Positive Only	As Indicated	A
10	>6" to 10"	Positive Only	As Indicated	A

1. Notes 1: Seal Class B required exceeding SMACNA minimum requirement.

1.05 REFERENCE STANDARDS

- A. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2024.
- B. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems; 2024.
- C. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations; 2024.
- D. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors; Current Edition, Including All Revisions.

1.06 SUBMITTALS

- A. Refer to other applicable sections for additional coordination drawings, duct shop drawings and product data and conform to provisions of Division 1.
- B. Shop Drawings:
 1. Prepare and submit ductwork shop drawings prior to fabrication and installation of ductwork. Contract documents are schematic in nature and are not an acceptable substitute for ductwork shop drawings.
 2. Include floor plans drawn to scale not less than 1"=1/4" over appropriate project backgrounds. Include duct elevations and sections where proposed duct configurations cannot be fully depicted in plan view.
 3. Include relevant details such as duct size dimensions, pressure classification, sheet metal gages, joining methodology, duct construction technology, fittings and duct accessories prior to start of work.
 4. Include coordination with the work of other applicable trades including architectural partitions, piping, electrical, lighting, and ceiling systems.
 5. Indicate bottom of duct elevation dimensions.
 6. Include details for offsets and transitions as required to permit ductwork to fit in the installation space allocated. Verify actual project field conditions and measurements as required.
 7. Owner assumes no responsibility for reimbursing additional costs for duct revisions and/or rework required as a result of failure to prepare fully developed and detailed shop drawings.
 - a. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:
 8. Submit the following according to Conditions of the Construction Contract.
 - a. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and protect products under provisions of Division 1.
- B. Protect duct from exposure to weather. Do not store duct in uncovered areas.
- C. Protect duct from contamination by covering openings until the time of installation. Maintain coverings over installed duct openings throughout construction progress until duct system is fully closed and complete.
- D. Prevent entry into and/or habitation of ductwork by animals during storage and construction.
- E. Restore ductwork to like-new condition or replace contaminated by lack of adequate protection at no additional cost to owner.

1.08 QUALITY CONTROL

- A. Obtain manufacturer's inspection and acceptance of installation of duct at beginning of installation for factory prefabricated duct systems.
- B. Provide 100% visual inspection of duct joint sealing prior to installation of thermal insulation coverings.
- C. PRESSURE TESTING
 - 1. Pressure test ducts rated for Pressure Class 3 inch (76.2 mm) or higher.
 - 2. Conduct tests using procedures consistent with SMACNA HVAC Duct Leakage Test Manual.
 - 3. Determine maximum acceptable rate of air leakage using duct leakage formula as follows:
 - a. $F = CL \times P^{0.65}$
 - b. Where: F = Maximum permissible airflow leakage in cfm/100 sq. ft. duct surface
 - c. P = Ducts static pressure in inch WG
 - d. CL = Leakage Class according to the table below

Duct Construction	Seal Class A	Seal Class B
Rectangular Construction	CL = 6	CL = 12
Round or Oval Construction	CL = 3	CL = 6

- 4. Conduct duct leakage tests witnessed in writing by owner's designated representative, independent TAB service, project commissioning authority, independent construction inspector, engineer of record, and/or authority having jurisdiction where required. Schedule testing with advance notification for test witness(s).
- 5. Correct and retest ducts failing leakage tests at no additional cost to owner.

PART 2 PRODUCTS

- a. Provide environmentally preferable products to the greatest extent possible.
- 2. To the greatest extent possible, provide products and materials that promote stewardship of the earth's resources, promote good indoor environmental quality (IEQ), and promote efficiencies in operational performance.
 - a. Provide products listed on the EPA Comprehensive Procurement Guidelines to the greatest extent practicable.
 - b. Provide products listed on the USGBC Directory of Products and Services to the greatest extent possible.
 - c. Provide recycled content products to the greatest extent possible.
- 3. To the greatest extent possible, provide materials with recycled content such that the sum of post-consumer recycled content plus one-half of the post-industrial content constitutes at least 10% of the total value of the materials in the project.
 - a. Provide Regional materials and products to the greatest extent possible that are extracted and manufactured within the region.

4. Provide materials and products that use a minimum of 20 % of building products that are manufactured regionally within a radius of 500 miles (804.67 kilometers) from the project site.
 - a. Manufacturing refers to the final assembly of components into the building product that is furnished and installed by the tradesman.
5. Of the regionally manufactured materials used and documented, use a minimum of 50% of building materials and products that are extracted, harvested or recovered (as well as manufactured) within 500 miles (804.67 kilometers) of the project site.

2.02 ACCEPTABLE MANUFACTURERS

- A. Flexible Duct Runouts
 1. Flex-master.
 2. Thermaflex
 3. JP Lamborn Co.

2.03 MATERIALS

- A. General: Non-combustible and conforming to requirements for Class 1 air duct materials, or UL 181.
- B. Non-Welded Steel Ducts: ASTM A525 galvanized steel sheet, lock-forming quality, having zinc coating of 1.25 oz per sq. ft. for each side in conformance with ASTM A90.
- C. Welded Carbon Steel Ducts: ASTM 568 rolled carbon steel; SMAW, FCAW, or GMAW welded; minimum 18 gauge sheet metal thickness.
- D. Welded Stainless Steel Ducts: ASTM A167, Type 304; GMAW welded; minimum 16 gauge sheet metal thickness.
- E. Fasteners: Rivets, bolts, or sheet metal screws matching base duct materials.
- F. Sealant: Non-hardening, water resistant, fire resistive, suitable for applications and compatible with mating materials
 1. High solids mastics - high density type with excellent adhesions and elasticity suitable for sealing fillets, groves, and flanges.
 2. Liquid sealants - formulated specifically for duct applications containing not more than 60% volatiles suitable for filling voids 1/16 inch (1.59 mm) or less. Provide taped joint reinforcement for liquid sealants except machine fabricated longitudinal seams and slip-type joints.
 3. Reinforcing tapes - suitable for use with liquid sealed joints only. Pressure sensitive adhesive tape sealing systems are not acceptable without liquid mastic overcoat.
 4. Gaskets: soft elastomeric butyl rubber with adhesive backing suitable for use with flanged joints.
 5. Liquid sealants containing not more than 50% volatiles. May be used for slip type joint assembly to fill voids up to 1/16 inch (1.59 mm) clearance.
- G. Hangers
 1. Strap: Steel, galvanized
 2. Rod: Steel, galvanized; continuously threaded.

2.04 CONSTRUCTION

- A. GALVANIZED STEEL RECTANGULAR DUCT
 1. Single or double wall construction as indicated by application.
 2. Minimum 26 gauge sheet metal thickness
 3. Longitudinal seams complying with the following industry standards:
 - a. Inside Groove Seam
 - b. Sliding Seam

-
- c. Pittsburgh Lock
 - d. Button-Punch Snap Lock
 - 4. Transverse joints complying with the following industry standards:
 - a. Drive Slip
 - b. S Slip
 - c. Reinforced Bar-S Slip
 - d. Pocket Joint
 - e. Flanged Systems (Ductmate, MEZ, or equal) comprised of;
 - 1) Rolled flanges with integral mastic seals
 - 2) Bolted preformed corner pieces
 - 3) Sealing gaskets
 - 4) Flange joint drive cleats
 - 5. Sealing Requirements
 - a. Class A – All transverse joints, longitudinal seams, and duct wall penetrations
 - b. Class B – All transverse joints and longitudinal seams
 - c. Class C – All transverse joints
 - 6. except that all duct joints and longitudinal seams for all SMACNA classes of duct shall be sealed with U.L. Listed Hardcast DT-tape and sealant FTA-20.
- B. GALVANIZED STEEL ROUND OR OVAL DUCT
- 1. Single or double wall construction as indicated by application.
 - 2. Minimum 26 gauge sheet metal thickness
 - 3. Longitudinal seams complying with the following industry standards:
 - a. Continuous interlocking spiral wound
 - b. Continuously seam welded
 - c. Butt seam welded
 - d. Gore locked seam
 - 4. Transverse joints complying with the following industry standards:
 - a. Pipe & fitting coupled slip joint with radial fasteners
 - b. Swedge sleeve
 - c. Welded flanged & gasketed
- C. WELDED LOW CARBON STEEL DUCT
- 1. Minimum 16 gauge thickness for grease laden exhaust service
 - 2. Minimum 18 gauge thickness for services other than grease laden exhaust
 - 3. Fully welded construction complying with one of the following industry standards
 - a. Shielded metal arc welding (SMAW)
 - b. Flux core arc welding (FCAW)
 - c. Gas metal arc welding (GMAW)
 - 4. Fully welded longitudinal joints and transverse seams for grease laden kitchen exhaust applications.
 - 5. Welded longitudinal seams with gasketed flanged transverse joints for applications other than grease laden kitchen exhaust.
- D. WELDED STAINLESS STEEL DUCT
- 1. Minimum 16 gauge thickness for laboratory exhaust service
 - 2. Minimum 18 gauge thickness for services other than laboratory exhaust
 - 3. Welded construction complying with industry standard gas metal arc welding (GMAW)
 - 4. Fully welded longitudinal joints and transverse seams with gasketed flanged connections at equipment connections only for laboratory exhaust applications.
 - 5. Welded longitudinal seams with gasketed flanged transverse joints for applications other than laboratory exhaust.

E. FLEXIBLE ROUND DUCT

1. Flexmaster type 5M insulated or equal.
2. Compliant with NFPA 90A & 90B
3. U.L. 181 Class 1 listed
4. ASTM E96 Procedure A rated for 0.05 Perm
5. Interlocking spiral wire of galvanized steel or aluminum construction
6. Aluminum foil, fiberglass, & aluminized polyester trilaminate liner
7. Rated to 6 inches (152.4 mm) WG positive and 1 inches (25.4 mm) WG negative
8. Insulated with 1" thick fiberglass insulation meeting R4.2
9. Reinforced metalized outer vapor barrier

F. DOUBLE WALL THERMAL DUCT FOR INTERIOR APPLICATIONS

1. Shop fabricated or factory prefabricated double wall duct systems consisting of continuous inner and outer wall metal duct sections with integral thermal insulation preinstalled in the annular space separating the inner and outer wall sections.
2. Reference Section 230713 HVAC Insulation, or other applicable Division 23 Sections for specific insulation requirements by application.
3. Paintable outer surface suitable for use in aesthetically exposed applications.
4. Comply with requirements of Galvanized Steel Rectangular, Round, and Oval Duct as applicable.
5. Provide double wall systems complete with all fittings, taps, and accessories.

G. DOUBLE WALL THERMAL DUCT FOR EXTERIOR EXPOSED APPLICATIONS

1. Shop fabricated or factory prefabricated double wall duct systems consisting of continuous inner and outer wall metal duct sections with integral thermal insulation preinstalled within the annular space separating the inner and outer wall sections.
2. Galvanized steel inner wall with welded stainless steel outer wall fabricated in flanged sections.
3. Reference Section 230713 HVAC Insulation, or other applicable Division 23 Sections for specific insulation requirements by application.
4. Inner duct wall complying with requirements of Galvanized Steel Rectangular, Round, and Oval Duct as applicable. Outer duct wall complying with requirements of Welded Stainless Steel Duct.
5. Provide double wall systems complete with all fittings, taps, and accessories.

H. DOUBLE WALL ACOUSTICAL DUCT

1. Shop fabricated or factory prefabricated double wall duct systems consisting of perforated inner and continuous outer wall metal duct sections with integral thermal acoustic insulation preinstalled in the annular space separating the inner and outer wall sections.
2. Provide inner duct with 3/32 inch (2.38 mm) diameter perforation holes staggered at 3/16 inch (4.76 mm) on center.
3. Reference Section 230713 HVAC Insulation, or other applicable Division 23 Sections for specific insulation requirements by application.
4. Paintable outer surface suitable for use in aesthetically exposed applications.
5. Conform to the requirements of galvanized steel rectangular, round, and oval duct as applicable.
6. Provide double wall systems complete with all fittings, taps, and accessories.

PART 3 EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

- A. Fabricate and support in accordance with SMACNA Duct Construction Standards and ASHRAE handbooks, except as indicated. Provide duct material, gages, reinforcing, and sealing for pressures indicated.

- B. Size round ducts installed in place of rectangular ducts in accordance with ASHRAE table of equivalent rectangular and round ducts. No reduction of equivalent duct area is permitted except by reviewed shop drawings.
- C. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- D. Construct duct fittings per SMACNA standard details.
 - 1. Provide typical supply, return and exhaust duct as detailed by SMACNA Section II fittings and other construction.
 - 2. The interior surface of all duct shall be smooth. No sheet metal parts, tabs, angles, or anything else may project into the ducts for any reason, except as specified to be so. All seams and joints shall be external.
 - 3. Provide 90 degree elbows constructed in accordance with SMACNA Figure 2-2, style RE-1 radius elbow (center line radius = 1.5 times duct height or width), space permitting; or style RE-2 square throat with turning vanes (provide duct access panel up stream of turning vanes for cleaning purposes) where required.
 - 4. Where rectangular elbows are used, provide single thickness turning vanes in accordance with SMACNA Figure 2.3; single wall type with trailing edge for duct velocities up to 1500 fpm and double wall turning vanes above 1500 fpm duct velocity.
 - 5. Provide parallel flow branches constructed in accordance with SMACNA Figure 2-7.
 - 6. Provide expanded 45 degree entry type rectangular duct branch connections.
 - 7. Provide spin-in type round branch duct connections in accordance with SMACNA Figure 2-8.
 - 8. Provide offsets and transitions in accordance with SMACNA Figure 2-9.
 - 9. Provide round spin-in fittings with locking quadrant volume dampers for all round duct connections to rectangular ducts. Spin-in and flex duct shall be same size as air distribution device neck diameter. Secure flex duct to spin-in and air distribution device neck with stainless steel worm gear clamps and seal vapor barrier. Suspend flex duct from structure above; round and flexible duct installations shall be as detailed by SMACNA in section III round, oval and flexible duct. Flexible duct supports shall be constructed and installed in accordance with SMACNA figures 3-9 and 3-10.
 - 10. Duct access doors shall be constructed in accordance with figure 2-12 and shall have a frame type 3, position 3 hinge with a type 2 locking handle; single and multi-blade volume dampers shall be in accordance with figures 2-14 and 2-15 respectively and shall have operator extensions when provided on externally insulated ducts; air distribution device connections shall be in accordance with figure 2-16 and ceiling diffuser branch ducts shall be in accordance with figure 2-17.
 - 11. Rectangular duct connections at all air moving equipment shall be flexible neoprene fabric and installed in accordance with figure 2-19.
 - 12. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible. Divergence upstream of equipment shall not exceed 30 degrees; convergence downstream shall not exceed 45 degrees.
 - 13. All duct shall be fabricated in a manner to prevent the seams or joints being cut for the installation of air distribution devices.
 - 14. Provide crimps in direction of air flow where crimp joints with bead are used for joining round duct sizes 6 inch (152.4 mm) smaller.
- E. Where required, provide ducts with "ESS"-drive joints or flat seams to allow crossing of duct or installation of other equipment or piping requiring tight clearances. Raise ducts where

required to allow installation of other duct or equipment using 45 degree radius elbows (center line radius = 1.5 times duct height) to offset.

- F. Provide openings in duct where required to accommodate thermometers and controllers. Provide pilot tube openings where required for testing of systems, complete with metal well and closure device to ensure against air leakage. Where openings are provided in insulated duct, install insulation material inside a metal ring.
- G. Connect fan coil units to low pressure OA intake ducts with short length of flexible duct. Hold in place with corrosion resistant clamp or strap.
- H. Connect air distribution devices to low pressure ducts with 6 feet (182.88 cm) maximum, 4 feet (121.92 cm) minimum, length of flexible duct. Hold in place with corrosion resistant strap or clamp.
- I. All rectangular duct located exposed on roof shall have top horizontal surface "crowned or sloped" to prevent water from ponding.

3.02 DUCT APPLICATION SCHEDULE

- A. Unless indicated otherwise, provide duct systems complying with the following application schedule:

AIR SYSTEM	CONSTRUCTION	MATERIAL	Pressure Class
Main Supply Above Ceiling or Concealed	Single Wall	Galvanized Steel	Per AHU ESP, 3" Class Minimum
Main Supply Exposed in Unoccupied Spaces	Single Wall	Galvanized Steel	Per AHU ESP, 3" Class Minimum
Main Supply Exposed in Occupied Spaces	Double Wall	Galvanized Steel	Per AHU ESP, 3" Class Minimum
Main Supply Exposed Exterior	Single Wall	Welded Carbon Steel	Per AHU ESP, 3" Class Minimum
Downstream Supply Above Ceiling or Concealed	Single Wall	Galvanized Steel	Per Terminal ESP
Downstream Supply Exposed in Occupied Spaces	Double Wall	Galvanized Steel	Per Terminal ESP
Draw-thru Transfer, Return, or Relief	Single Wall	Galvanized Steel	1" Class
Pressurized Transfer, Return, or Relief	Single Wall	Galvanized Steel	Per Fan ESP
Draw-thru O/A Intake Above Ceiling or Concealed	Single Wall	Galvanized Steel	1" Class
Draw-thru O/A Intake Exposed in Occupied Spaces	Double Wall	Galvanized Steel	1" Class
Pressurized O/A Intake Above Ceiling or Concealed	Single Wall	Galvanized Steel	Per Fan ESP, 2" Class Minimum

Pressurized O/A Intake Exposed in Occupied Spaces	Double Wall	Galvanized Steel	Per Fan ESP, 2" Class Minimum
General Exhaust	Single Wall	Galvanized Steel	Per Fan ESP, 1" Class Minimum
Grease Laden Kitchen Exhaust	Single Wall	Welded Carbon Steel	Per Fan ESP, comply with local code
Kitchen Dishwasher Exhaust	Single Wall	Welded Stainless Steel	Per Fan ESP, 18 Gauge Minimum
Laboratory Exhaust (General & Fume Hood)	Single Wall	Welded Stainless Steel	Per Fan ESP. 16 Gauge Minimum

3.03 DUCT HANGERS AND SUPPORTS

- A. All duct shall be properly suspended or supported from the building structure.
- B. The spacing, size and installation of hangers shall be in accordance with the recommendations of SMACNA, latest edition.
- C. Hangers shall be galvanized steel straps or hot-dipped galvanized rod with threads pointed after installation. Hangers shall be attached to the bottom of the duct.
- D. Provide double nuts and lock washers on threaded rod supports
- E. All duct shall be mounted tight to underside of structure and shall be top level with bottom and side transitions only, except that allowance shall be made for duct to be externally insulated, which shall be mounted 3" below structural beams and joists or other obstruction to allow installation of the external duct insulation.
- F. All duct risers shall be supported by angles or channels secured to the sides of the ducts at each floor. Secure floor supports to duct using rods, angles or flat bar to the duct joint or reinforcing. Provide miscellaneous steel supports for duct risers as required at no additional cost to owner.
- G. Where ducts pass through walls in exposed areas, provide framed openings constructed of welded metal angles. All angles shall be carried around all four sides of the duct or group of ducts.

3.04 ADJUSTING AND CLEANING

- A. Clean duct system by vacuuming and force air at high velocity through duct to remove accumulated dust. To obtain sufficient air, clean half the system at a time. Protect equipment which may be harmed by excessive dirt with temporary filters, or bypass during cleaning.

3.05 TESTING

- A. Pressure test ductwork per Quality Control requirements.

END OF SECTION

PART 1 GENERAL

1.01 REFERENCE STANDARDS

- A. AMCA 500-D - Laboratory Methods of Testing Dampers for Rating; 2018.
- B. ASTM A480/A480M - Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip; 2025b.
- C. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2025a.
- D. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.
- E. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2024.
- F. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems; 2024.
- G. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors; Current Edition, Including All Revisions.
- H. UL 555 - Standard for Fire Dampers; Current Edition, Including All Revisions.
- I. UL 555S - Standard for Smoke Dampers; Current Edition, Including All Revisions.

1.02 RELATED DOCUMENTS

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

1.03 SUMMARY

- A. Section Includes:
 - 1. Backdraft and pressure relief dampers.
 - 2. Barometric relief dampers.
 - 3. Manual volume dampers.
 - 4. Control dampers.
 - 5. Fire dampers.
 - 6. Duct-mounted access doors.
 - 7. Flexible connectors.
 - 8. Flexible ducts.
 - 9. Duct accessory hardware.
- B. RELATED SECTIONS:
 - 1. Section 013300 Submittals.
 - 2. Section 01524 Construction Waste Management
 - 3. Section 01352 LEED Requirements
 - 4. Section 01611 Environmental Management
 - 5. Section 01570 Pollution Prevention and Control

1.04 SUBMITTALS

- A. Product Data: For each type of product indicated.
 - 1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.
- B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.
 - 1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:

- a. Special fittings.
 - b. Manual volume damper installations.
 - c. Control damper installations.
 - d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
 - e. Duct security bars.
- C. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.
- D. Source quality-control reports.
- E. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.05 QUALITY ASSURANCE

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. Comply with AMCA 500-D testing for damper rating.

1.06 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A653/A653M.
 - 1. Galvanized Coating Designation: G90 (Z275).
 - 2. Exposed-Surface Finish: Mill phosphatized.
- C. Stainless-Steel Sheets: Comply with ASTM A480/A480M, Type 304, and having a No. 2 finish for concealed and exposed ducts.
- D. Aluminum Sheets: Comply with ASTM B 209 (ASTM B 209M), Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- E. Extruded Aluminum: Comply with ASTM B221 (ASTM B 221M), Alloy 6063, Temper T6.
- F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- G. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches (914.4 mm) or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (914.4 mm).

2.02 BACKDRAFT AND PRESSURE RELIEF DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. American Warming and Ventilating; a division of Mestek, Inc.
 - 2. Greenheck Fan Corporation.
 - 3. Nailor Industries Inc.

-
- 4. Pottorff; a division of PCI Industries, Inc.
 - 5. Ruskin Company.
 - 6. American Warming and Ventilating.
 - B. Description: Gravity balanced.
 - C. Maximum Air Velocity: 2000 fpm.
 - D. Maximum System Pressure: 2-inch wg.
 - E. Frame: 0.063-inch- thick extruded aluminum with welded corners and mounting flange.
 - F. Blades: Multiple single-piece blades, maximum 6-inch width, 0.025-inch- thick, roll-formed aluminum noncombustible with sealed edges.
 - G. Blade Action: Parallel.
 - H. Blade Seals: Neoprene, mechanically locked.
 - I. Blade Axles:
 - 1. Material: Stainless steel.
 - 2. Diameter: 0.20 inch (5.08 mm).
 - J. Tie Bars and Brackets: Galvanized steel.
 - K. Return Spring: Adjustable tension.
 - L. Bearings: Synthetic pivot bushings.
 - M. Accessories:
 - 1. Adjustment device to permit setting for varying differential static pressure.
 - 2. Counterweights and spring-assist kits for vertical airflow installations.
 - 3. Electric actuators.
 - 4. Chain pulls.
 - 5. Screen Mounting: Front mounted in sleeve.
 - a. Sleeve Thickness: 20-gage minimum.
 - b. Sleeve Length: 6 inches (152.4 mm) minimum.
 - 6. Screen Material: Aluminum.
 - 7. Screen Type: Bird.
 - 8. 90-degree stops.

2.03 BAROMETRIC RELIEF DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Air Balance Inc.; a division of Mestek, Inc.
 - 2. American Warming and Ventilating; a division of Mestek, Inc.
 - 3. Greenheck Fan Corporation.
 - 4. Lloyd Industries, Inc.
 - 5. Nailor Industries Inc.
 - 6. Pottorff; a division of PCI Industries, Inc.
 - 7. Ruskin Company.
 - 8. American Warming and Ventilating.
- B. Suitable for horizontal or vertical mounting.
- C. Maximum Air Velocity: 2000 fpm.
- D. Maximum System Pressure: 2-inch wg.
- E. Frame: 0.063-inch- (thick extruded aluminum], with welded corners and mounting flange.
- F. Blades:
 - 1. Multiple, 0.025-inch-thick, roll-formed aluminum.

-
2. Maximum Width: 6 inches (152.4 mm).
 3. Action: Parallel.
 4. Balance: Gravity.
 5. Eccentrically pivoted.
- G. Blade Seals: Neoprene.
- H. Blade Axles: Nonferrous metal.
- I. Tie Bars and Brackets:
1. Material: Aluminum
 2. Rattle free with 90-degree stop.
- J. Return Spring: Adjustable tension.
- K. Bearings: Synthetic.
- L. Accessories:
1. Flange on intake.
 2. Adjustment device to permit setting for varying differential static pressures.
 3. MANUAL VOLUME DAMPERS
- M. Standard, Steel, Manual Volume Dampers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Air Balance Inc.; a division of Mestek, Inc.
 - b. American Warming and Ventilating; a division of Mestek, Inc.
 - c. McGill AirFlow LLC.
 - d. METALAIRE, Inc.
 - e. Nailor Industries Inc.
 - f. Pottorff; a division of PCI Industries, Inc.
 - g. Ruskin Company.
 - h. Trox USA Inc.
 - i. American Warming and Ventilating.
 2. Standard leakage rating, with linkage outside air stream.
 3. Suitable for horizontal or vertical applications.
 4. Frames:
 - a. Hat-shaped, galvanized channels, 0.064-inch minimum thickness.
 - b. Mitered and welded corners.
 - c. Flanges for attaching to walls and flangeless frames for installing in ducts.
 5. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.
 - c. Stiffen damper blades for stability.
 - d. Galvanized, 0.064 inch (1.63 mm) thick.
 6. Blade Axles: Nonferrous metal.
 7. Bearings:
 - a. Oil-impregnated bronze.
 - b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
 8. Tie Bars and Brackets: Galvanized steel.

2.04 FIRE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, [provide products by one of the following:
1. American Warming and Ventilating.

-
2. Greenheck Fan Corporation.
 3. METALAIRE, Inc.
 4. Nailor Industries Inc.
 5. Pottorff; a division of PCI Industries, Inc.
 6. Prefco; Perfect Air Control, Inc.
 7. Ruskin Company.
- B. Type: Static; rated and labeled according to UL 555 by an NRTL.
- C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 4000-fpm velocity.
- D. Fire Rating: 1-1/2 hours.
- E. Frame: Curtain type with blades outside air stream fabricated with roll-formed, 0.034-inch thick galvanized steel; with mitered and interlocking corners.
- F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
1. Minimum Thickness: 0.052 or 0.138 inch (3.51 mm) thick, as indicated, and of length to suit application.
 2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.
- G. Mounting Orientation: Vertical or horizontal as indicated.
- H. Blades: Roll-formed, interlocking, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.
- I. Horizontal Dampers: Include blade lock and stainless-steel closure spring.
- J. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.
- K. Furnish and install where shown on the drawings or required by the Specifications, fire dampers meeting the following requirements.
- L. Each fire damper shall be constructed and tested in accordance with Underwriters Laboratories Safety Standard 555. All dampers shall possess a 1-1/2 hour or 3 hour (as appropriate for the construction shown in the architectural drawings) protection rating, 165 or 212 degree F fusible link, and shall bear a U.L. label in accordance with Underwriters Laboratories labeling procedures. Fire dampers shall be constructed such that the damper frame material and the curtain material shall be galvanized.
- M. Fire dampers shall be curtain blade or multi-blade type and the damper shall be so constructed that the blades are either out of the air stream or installed in an oversized sleeve to provide a 100 percent free area of the duct in which the damper is housed.
- N. The damper manufacturer's literature submitted for approval prior to the installation shall include performance data developed from testing in accordance with AMCA 500 Standards and shall show the pressure drops for all sizes of dampers required at anticipated air flow rates. Maximum pressure drop through fire damper shall not exceed 0.05 inch (1.27 mm) water gauge.
- O. Fire dampers shall be equipped for vertical or horizontal installation as required by the locations shown in the drawings. Fire dampers shall be installed in wall and floor openings utilizing steel sleeves, angles and other material and practices required to provide an installation equivalent to that utilized by the manufacturer when the respective dampers were tested by Underwriters Laboratories. Mounting angles shall be a minimum of 1 1/2 inch (12.7 mm) by 1 1/2 inch by 14-gauge and bolted, tack welded or screwed to the sleeve at maximum spacings of 12 inches (304.8 mm) and with a minimum of two connections at all sides. Mounting angles shall overlap at least equal to the gauge of the duct defined by the appropriate SMACNA Duct Construction Standard, latest edition, and as described in NFPA 90A. The entire assembly, following installation, shall be capable of withstanding 6" water gauge static pressure.

-
- P. The damper installation shall be in accordance with the damper manufacturer's instructions.
- Q. All fire dampers shall comply with the specification as written above and shall be Ruskin Model IBD2 (Style C, CR or CO), Greenheck Model FD-150 (Type C, CR or CO), or Pottorff.
- R. The contractor shall completely seal the assembly to the building components using Hardcast 1602 sealant tape to allow for expansion and contraction of the sleeve and damper assembly.
- S. Dampers shall be UL labeled for use in dynamic systems. Closure reading shall be 110% of the maximum design airflow at the point of installation. The minimum closure pressure rating shall be 8" wg for airflow in either direction.
- T. Combination Fire/Smoke Dampers
1. Furnish and install where shown on the Drawings, or as required by the Specifications, combination fire/smoke dampers meeting the following requirements.
 2. Each combination fire/smoke damper shall be 1 1/2 hour fire rated under UL Standard 555, 4th Edition, and shall be further classified by Underwriters Laboratories as a Leakage Rated Damper for use in smoke control systems under the latest version of UL 555S, and bear a UL label attesting to same. The damper manufacturer shall have tested, and qualified with UL, a complete range of damper sizes covering all dampers required by this Specification. Testing and UL qualifying a single damper size is not acceptable. The leakage rating under UL 555S shall be no higher than Leakage Class I (4 cfm per square foot at one inch water gauge pressure and 8 cfm per square foot at 4 inches (101.6 mm) water gauge pressure). The maximum air pressure drop through each combination fire/smoke damper shall not exceed 0.10 inch (2.54 mm) water gauge at the design air quantity. (Note that this may require a larger damper than the connected duct size.)
 3. The damper frame shall be a minimum of 20-gauge galvanized steel formed into a structural hat channel shape with tabbed corners for reinforcement, as approved in testing by Underwriters Laboratories. Bearings shall be integral high surface area non electrolytic materials construction to incorporate a friction free frame blade lap seal, or molybdenum disulfide impregnated stainless steel or bronze oilite sleeve type turning in an extruded hole in the frame or an extruded frame raceway. The dampers may be either parallel or opposed blade type. The blades shall be constructed with a minimum of 14-gauge equivalent thickness. The blade edge seal material shall be able to withstand 450 degrees Fahrenheit (232.22 degrees Celsius). The jamb seals shall be flexible stainless steel compression type or lap seal type.
 4. In addition to the leakage ratings specified herein, the combination fire/smoke dampers and their operators shall be qualified under UL 555S to an elevated temperature of 250 degrees Fahrenheit (121.11 degrees Celsius). Electric operators shall be installed by the damper manufacturer at the time of damper fabrication. The damper and operator shall be supplied as a single entity which meets all applicable UL 555 and UL 555S qualifications for both dampers and operators. The manufacturer shall provide a factory assembled sleeve. The sleeve shall be a minimum of either 20-gauge for dampers where neither width nor height exceeds 48 inches (1219.2 mm) or 16-gauge where either dimension equals or exceeds 48 inches.
 5. As part of the UL qualification, dampers shall have demonstrated a capacity to operate (open and close) under HVAC system operation conditions, with pressures of at least 4 inches (101.6 mm) water gauge in the closed position, and 2500 fpm air velocity in the open position.
 6. Each combination fire/smoke damper shall be equipped with a UL Classified Firestat /releasing device. The firestat/releasing device shall electrically and mechanically lock the damper in a closed position when the duct temperatures exceed 165 degrees Fahrenheit (73.89 degrees Celsius) and still allow the appropriate authority to operate the damper as may be required for smoke control functions. The damper must be operable while the temperature is above 250 degrees Fahrenheit (121.11 degrees Celsius). The

actuator/operator package shall include two damper position indicator switches linked directly to damper blade to provide capability of remotely indicating damper position. One switch shall close when the damper is fully open, and the other switch shall close when the damper is fully closed. The Firestat/releasing device and position indicator switches shall be capable of interfacing electrically with the smoke detectors, building fire alarm systems, and remote indicating/control stations.

7. The damper releasing device shall be mounted within the airstream. The device shall be activated and the damper shall close and lock when subjected to duct temperatures in excess of approximately 285 degrees Fahrenheit (140.56 degrees Celsius).
8. Motors for operation of smoke dampers shall be smoke system fail safe, spring return normally open supplies and normally closed returns, or as indicated in the plans, and shall be furnished and installed by the damper manufacturer as required by the U.L. rating mentioned above. Motors shall be electric or pneumatic to match the type of temperature control system specified elsewhere in this specification. All required relays, EP switches, wiring piping and other labor and material necessary to completely interconnect the smoke detector system shall be furnished by the Contractor.
9. Each damper shall be furnished in a square or rectangular configuration. The Contractor shall furnish and install sleeves manufactured by the approved damper manufacturer for each damper. The sleeves shall be constructed with square or rectangular to square, rectangular, round, or oval adapters as required. Dampers shall be installed in the sleeves in accordance with manufacturers U.L. installation instructions. The entire assembly, following installation, shall be capable of withstanding 6" W.G. static pressure.
10. All combination fire/smoke dampers shall comply with the specification as written above and shall be Ruskin Model FSD-60, Greenheck Model FSD-33, or Pottorff.
11. The contractor shall completely seal the assembly to the building components using Hardcast 1602 sealant tape to allow for expansion and contraction of the sleeve and damper assembly.
12. Dampers shall be UL labeled for use in dynamic systems. Closure reading shall be 110% of the maximum design air flow at the point of installation. The minimum closure pressure rating shall be 8" wg for air flow in either direction.

2.05 DUCT-MOUNTED ACCESS DOORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. American Warming and Ventilating; a division of Mestek, Inc.
 2. Flexmaster U.S.A., Inc.
 3. Greenheck Fan Corporation.
 4. McGill AirFlow LLC.
 5. Nailor Industries Inc.
 6. Pottorff; a division of PCI Industries, Inc.
 7. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-10, "Duct Access Doors and Panels," and 2-11, "Access Panels - Round Duct."
 1. Door:
 - a. Double wall, rectangular.
 - b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
 - c. Vision panel.
 - d. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
 - e. Fabricate doors airtight and suitable for duct pressure class.
 2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.

3. Number of Hinges and Locks:
 - a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
 - b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.
 - c. Access Doors up to 24 by 48 Inches: Three hinges and two compression latches.
Access Doors Larger Than 24 by 48 Inches: Four hinges and two compression latches with outside and inside handles.
- C. Pressure Relief Access Door:
 1. Door and Frame Material: Galvanized sheet steel.
 2. Door: Double wall with insulation fill with metal thickness applicable for duct pressure class.
 3. Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts.
 4. Factory set at 10-inch wg.
 5. Doors close when pressures are within set-point range.
 6. Hinge: Continuous piano.
 7. Latches: Cam.
 8. Seal: Neoprene or foam rubber.
 9. Insulation Fill: 1-inch thick, fibrous-glass or polystyrene-foam board.

2.06 FLEXIBLE DUCTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Flexmaster U.S.A., Inc.
 2. McGill AirFlow LLC.
 3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Insulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor-barrier film.
 1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
 2. Maximum Air Velocity: 4000 fpm.
 3. Temperature Range: Minus 10 to plus 160 deg F.
 4. Insulation R-value: Comply with ASHRAE/IESNA 90.1-2004.
- C. Insulated, Flexible Duct: UL 181, Class 1, multiple layers of aluminum laminate supported by helically wound, spring-steel wire; fibrous-glass insulation; aluminized vapor-barrier film.
 1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
 2. Maximum Air Velocity: 4000 fpm.
 3. Temperature Range: Minus 20 to plus 210 deg F.
 4. Insulation R-value: Comply with ASHRAE/IESNA 90.1-2004.
- D. Flexible Duct Connectors:
 1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches (457.2 mm) to suit duct size.
 2. Non-Clamp Connectors: Adhesive plus sheet metal screws.
- E. DUCT ACCESSORY HARDWARE
 1. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.
 2. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

2.07 LOW PRESSURE TAPS (CONICAL BELL MOUTH FITTINGS)

- A. Conical fittings may be used for duct taps and shall include quadrant dampers on all lines to air devices (diffusers and grilles), even though a volume damper is specified for the air device. (This does not apply to medium pressure duct.) Spin-in fittings shall be sealed at the duct tap with a gasket, or compression fit, or sealed with sealant specified for medium pressure ductwork. The location of spin-in fittings in the ducts shall be determined after dual or single duct terminal units are hung or the location of the light fixtures is known so as to minimize flexible duct lengths and sharp bends.
- B. The conical fitting shall be made of at least 26-gauge galvanized sheet metal. The construction to be a two-piece fitting with a minimum overall length of 6 inches (152.4 mm) and shall be factory sealed for high pressure requirements. Average loss coefficient for sizes 6, 8, and 10 shall be less than 0.055.
- C. Each to be provided with minimum 24-gauge damper plate with locking quadrant operator and sealed end bearings. Damper blade shall be securely attached to shaft to prevent damper from rotating around shaft.
- D. Provide flange and gasket with adhesive peel-back paper for ease of application. The fitting shall be further secured by sheet metal screws spaced evenly at no more than 4 inches (101.6 mm) on-center with a minimum of four screws per fitting.
- E. The conical bellmouth fitting shall be Series 3000G as manufactured by Flexmaster U.S.A., Inc., or Buckley Air Products, Inc., 'AIR-TITE'.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

3.02 DAMPERS

- A. Furnish and install dampers where shown on the Drawings and wherever necessary for complete control of the air flow, including all supply, return and exhaust branches, "division" in main supply, return and exhaust ducts, each individual air supply outlet and fresh air ducts. Where access to dampers through a fixed suspended ceiling is necessary, the Contractor shall be responsible for the proper location of the access doors.
- B. Splitter dampers shall be fabricated of steel not lighter than 16-gauge. The leading edge of the damper shall be hemmed. Each splitter shall be a minimum of 12" long or 1-1/2 times the width of the smaller of the two branches it controls, whichever is greater. Dampers shall be carefully fitted, and shall be controlled by locking quadrants equal to Ventlok No. 555 on exposed uninsulated ductwork, No. 644 on exposed externally insulated ductwork and No. 677 (2-5/8" diameter) chromium plated cover plate for concealed ductwork not above lay-in accessible ceilings. Furnish and install end bearings for the damper rods on the end opposite the quadrant when No. 555 or No. 644 regulators are used, and on both ends when No. 677 regulators are used.
- C. On concealed ductwork above lay-in accessible ceilings use Ventlok No. 555 or No. 644 locking quadrant for splitter dampers.
- D. Dampers larger than three (3) square feet in area shall be controlled by means of rods hinged near the leading edge of the damper with provisions for firmly anchoring the rod and with end bearings supporting the axle.

- E. Volume dampers shall be equal to those of American Foundry. Blades shall not exceed 48 inches (1219.2 mm) in length or twelve inches (12") in width and shall be of the opposed interlocking type. The blades shall be of not less than No. 16-gauge galvanized steel supported on one-half inch (1/2") diameter rust-proofed axles. Axle bearings shall be the self-lubricating ferrule type.
- F. Install all dampers furnished by the Temperature Control Manufacturer in strict accordance with the manufacturer's recommendations and requirements of these Specifications.
- G. All adjustable dampers installed in externally insulated ductwork shall be installed with Ventlok No. 639, or equal, elevated dial operators. Insulation shall extend under the elevated dial. All adjustable dampers installed in internally insulated ductwork shall be installed with Ventlok No. 635, or equal, dial operators. All damper shaft penetrations in the ductwork shall be installed with Ventlok #609 end bearings.
- H. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
 - 1. Install steel volume dampers in steel ducts.
 - 2. Install aluminum volume dampers in aluminum ducts.
- I. Set dampers to fully open position before testing, adjusting, and balancing.
- J. Install test holes at fan inlets and outlets and elsewhere as indicated.
- K. Install fire dampers according to UL listing.
- L. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
 - 1. On both sides of duct coils.
 - 2. Upstream from duct filters.
 - 3. At outdoor-air intakes and mixed-air plenums.
 - 4. At drain pans and seals.
 - 5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
 - 6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
 - 7. At each change in direction and at maximum 50-foot spacing.
 - 8. Upstream and downstream from turning vanes.
 - 9. Upstream or downstream from duct silencers.
 - 10. Control devices requiring inspection.
 - 11. Elsewhere as indicated.
- M. Install access doors with swing against duct static pressure.

3.03 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Operate dampers to verify full range of movement.
 - 2. Inspect locations of access doors and verify that purpose of access door can be performed.
 - 3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
 - 4. Inspect turning vanes for proper and secure installation.

5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Furnish and install roof and wall exhausters and cabinet and ceiling exhaust fans for mechanical systems.

1.02 REFERENCE STANDARDS

- A. AMCA 99 - Standards Handbook; 2025.
- B. AMCA 210 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating; 2025.
- C. AMCA 300 - Reverberation Room Methods of Sound Testing of Fans; 2024.
- D. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data; 2022.

1.03 RELATED SECTIONS

- A. Section 016600 – Product Storage and Handling Requirements.
- B. Section 016613 – Product Storage and Handling Requirements for Hazardous Materials.
- C. Section 016616 – Product Storage and Handling Requirements for Toxic Materials.
- D. Section 220526 – Hangers and Supports for Plumbing Piping and Equipment.
- E. Section 220543 – Vibration and Seismic Control for Plumbing and Piping Equipment.
- F. Section 233100 – HVAC Ducts and Casings.
- G. Section 233416 – Centrifugal HVAC Fans.
- H. Section 230593 – Testing, Adjusting, and Balancing for HVAC.
- I. Section 230513 – Common Motor Requirements for HVAC.
- J. Coordinate with Commissioning Requirements indicated in Section 019113. This contractor is responsible to comply with all requirements for the above section.
- K. Section 013300 Submittals.
- L. Section 01524 Construction Waste Management
- M. Section 01352 LEED Requirements
- N. Section 01611 Environmental Management
- O. Section 01570 Pollution Prevention and Control

1.04 REFERENCES

- A. AMCA 99 – Standards Handbook.
- B. AMCA 210 – Laboratory Methods of Testing Fans for Rating Purposes.
- C. AMCA 300 – Test Code for Sound Rating Air Moving Devices.
- D. AMCA 301 – Method of Publishing Sound Ratings for Air Moving Devices.
- E. SMACNA – Low Pressure Duct Construction Standard.

1.05 SUBMITTALS

- A. Include fan curves with specified operating point clearly plotted.
- B. Include sound power levels for both fan inlet and outlet at rated capacity.
- C. Indicate special coating when required.
- D. Provide operation and maintenance manual.
- E. Operation and Maintenance Data: For centrifugal fans to include in emergency, operation, and maintenance manuals.

1.06 QUALITY ASSURANCE

- A. Performance Ratings: Conform to AMCA 210 and bear the AMCA Certified Rating Seal.
- B. Sound Ratings: AMCA 301, tested to AMCA 300.
- C. Fabrication: Conform to AMCA 99.

1.07 MAINTENANCE

- A. Provide twelve (12) months maintenance of all materials and equipment under this section.
Cost of the twelve (12) month normal and preventive maintenance shall be included within this scope of work.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Greenheck.
- B. Cook.
- C. Penn Barry
- D. Acme

2.02 ROOF EXHAUSTERS

- A. Centrifugal or Axial Fan Unit: Backward inclined or airfoil design, v-belt or direct driven, with spun aluminum housing, resilient mounted motor and drive assembly, 1/2-inch mesh, 16 gauge aluminum bird screen; square base to suit roof curb with continuous curb gaskets; secured to roof curb with cadmium plated or stainless steel bolts and screws, as indicated in Drawings.
- B. Roof Curb: 14 inch (355.6 mm) with continuously welded seams, built-in cant strip, 1 inch (25.4 mm) insulation and curb bottom, hinged curb adapter and factory installed door mailer strip. Where scheduled, provide interior baffle with acoustic insulation and increase curb height as required.
- C. Disconnect Switch: Factory wired, non-fusible, in housing for thermal overload protected motor.
- D. Back draft Damper: Gravity activated, aluminum multiple blade construction, felt edged with nylon bearings.
- E. Sheaves: Cast-iron or steel, dynamically balanced, bored to fit shafts and keyed; adjustable pitch motor sheave selected so required rpm is obtained with sheaves set at mid position; and will not overload motor when adjusted to maximum pitch; fan shaft with self-aligning pre-lubricated ball bearings.
- F. Apply three coats of air dried Heresite coating both internal and external to all roof exhausters from corrosive areas.
- G. Motors: In total compliance with Section 230513.

2.03 UP-BLASTS EXHAUST FANS

- A. Centrifugal Fan Unit: Non-overloading backward inclined or airfoil design, v-belt driven, with spun aluminum housing, resilient mounted motor and drive assembly located out of airstream; square base to suit roof curb with continuous curb gaskets; secured with cadmium plated or stainless steel bolts and screws.
- B. Motor enclosures: Totally enclosed fan cooled
 - 1. Motors are heavy duty ball bearing type to match with the fan load and furnished at the specific voltage and phase.
 - 2. Mounted on vibration isolators, out of the airstream
 - 3. For motor cooling there shall be fresh air drawn into the motor compartment through an area free of discharge contaminants.
 - 4. Accessible for maintenance.

- C. Shafts and Bearings:
 - 1. Fan shaft shall be ground and polished solid steel with an anti corrosive coating.
 - 2. Permanently sealed bearings or pillow block ball bearings.
 - 3. Bearing shall be selected for a minimum L10 life in excess of 100,000 hours (equivalent to L50 average life of 500,000 hours), at maximum cataloged operating speed.
 - 4. Bearings are 100 percent factory tested
 - 5. Fan Shaft first critical speed is at least 25 percent over maximum operating speed
- D. Roof Curb: 14 inch (355.6 mm) high aluminum construction with continuous seams, built-in cant strip and factory installed mailer strip. Roof curb shall match fan and shall be supplied by fan manufacturer. Provide sloped roof curb as required for installed equipment to set level.
- E. Disconnect Switch: Factory wired, non-fusible, in housing for thermal overload protected motor.
- F. Grease Collector: Provide grease trough and collectors for kitchen hood fans.
- G. Sheaves: Cast-iron or steel, dynamically balanced, bored to fit shafts and keyed; adjustable pitch motor sheave selected so required rpm is obtained with sheaves set at mid position; and will not overload motor when adjusted to maximum pitch; fan shaft with self-aligning pre-lubricated ball bearings. Drive shall be designed for 165% of rated horsepower capabilities.
- H. Motors: In total compliance with Section 230513.

2.04 KITCHEN SUPPLY AIR FAN

- A. Kitchen Supply Fan shall be as manufactured by Greenheck or approved equal provided all specifications are met. Greenheck Model KSF equipment is used as the basis of design.
- B. Unit shall be of internal frame type construction of galvanized steel. All frames and panels shall be G90 galvanized steel. All metal-to-metal surfaces exposed to the weather shall be sealed, requiring no caulking at job site. Unit base to be designed for curb mounting. Unit base shall over hang the curb. Curb is recessed under the unit for a positive seal against water run-off. All components shall be easily accessible through removable doors. Permatector corrosion resistant exterior finish available for outdoor units.
- C. Weather hood shall be the same finish as the unit and shall be sized for low intake velocities, preventing entrainment of moisture.
- D. Filters shall be mounted in a straight or V-bank arrangement such that velocities across the filters do not exceed 550 feet (16764 cm) per minute. Filters shall be 1 inch (25.4 mm) or 2 inch (50.8 mm) aluminum mesh and easily removable.
- E. Centrifugal fans shall be double width, double inlet. Fan and motor shall be mounted on a common base and shall be internally isolated. All blower wheels shall be statically and dynamically balanced. Ground and polished steel fan shafts shall be mounted in permanently sealed ball bearing pillow blocks. Bearings shall be selected for a minimum (L10) life in excess of 100,000 hours at maximum cataloged speeds.
- F. Motors shall be energy efficient, complying with EPACT standards, for single speed ODP and TE enclosures. Motors shall be permanently lubricated, heavy duty type, matched to the fan load and furnished at the specified voltage, phase and enclosure. Drives shall be sized for a minimum of 150% of driven horsepower. Pulleys shall be fully machined cast, 10 horse power and less shall be supplied with an adjustable drive pulley.
- G. Control center shall include magnetic motor starter with thermal overload protection and manual reset, control circuit fusing, control transformer for 24 VAC circuit, integral door interlocking disconnect switch and distribution terminal strip. All internal electrical components shall be prewired for single point power connection. All electrical components shall be UL listed, approved or classified where applicable and wired in compliance with the National Electrical Code. Contactors and Class 20 adjustable overload protection shall be standard.

2.05 SOURCE QUALITY CONTROL

- A. The following tests must be conducted at the project site.
 - 1. Vibration test as described in Section 016600 – Product Storage and Handling Requirements, Section 016613 – Product Storage and Handling Requirements for Hazardous Materials, and Section 016616 – Product Storage and Handling Requirements for Toxic Materials.
- B. The following listed tests must be conducted at the manufacturer=s test facility.
 - 1. Vibration test as described in Section 230593 – Testing, Adjusting, and Balancing for HVAC.
 - 2. Sound test under AMCA Guidelines and Conditions. The sound power levels must not exceed those indicated on Drawings.

2.06 ACCESSORIES

- A. Inlet mixing plenums shall be provided by the fan manufacturer. Each plenum shall be sized to support the weight and performance requirements of the number of fans listed on the schedule. Multiple fan plenums shall be double wall construction with structural stiffeners or shall be continuously welded, heavy gauge single wall construction. Single fan plenums shall be of continuously welded, heavy gauge steel construction. All plenums shall be capable of supporting the fan(s) without guy wires or supports. The plenums shall include hinged access doors and safety screens over primary air inlets. The primary air inlets shall be located on the bottom or side as noted on construction drawings. Coatings shall be the same as specified for the fans. Unless otherwise specified, plenums shall be suitable for mounting on roof curbs.
- B. Stainless safety screens shall be supplied over bottom primary air inlets.
- C. Bypass dampers shall be provided with all mixing plenums for outside make-up air with primary exhaust. Dampers will be:
 - 1. Louver/damper combinations, aluminum construction, manual locking quadrant.
 - 2. Opposed blade low leakage airfoil control dampers with extended shaft for connection to an operator. The dampers shall be aluminum construction. Rain hoods shall be provided with each damper. The dampers shall be controlled by a (hand quadrant/20 psi pneumatic/24V electric) operators. The operators shall be provided by controls manufacturer.
 - 3. Barometric controlled dampers, adjustable up to 3.0" pressure. Rain hood shall be provided with each damper.
- D. Low leakage isolation dampers shall be constructed of aluminum airfoil extrusions and coated with epoxy. Operators shall be 2 position, spring return and shall be 20 PSI pneumatic/24V/110V electric unless variable frequency drives are specified. The electric operator shall be factory wired (via a transformer when required) to the fan disconnect switch to open when the fan is energized and close via a spring return when de-energized. When the fan ships separate from the plenum, all wiring and conduit shall be factory supplied for easy connection in the field.
- E. Vortex breakers shall be provided on all side inlet and multiple fan plenums.
- F. Inlet spray nozzle(s) shall be mounted at fan inlet to provide wash down capability of fan while operating. Spray nozzles to be suitable for water or stream. Nozzles to be piped to the exterior of the fan with threaded end for field connection. All piping and nozzle components shall be stainless steel construction.
- G. A 14 gauge galvanized steel roof curb shall be provided to support the fans/plenums. The curb shall be minimum 14 gauge and canted for rigid in wind loads. The curb shall be _" high. The curb shall include a rigid fiberglass liner wood nailer.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Secure roof exhausters with 1/2" x 2" S.S. lag screws roof curb.
- C. Install flexible ductwork connections when fan connects to ductwork.
- D. Provide all ventilating and exhaust fans with integral vibration isolation.
- E. Water test ventilators after installation.

3.02 PAINTING

- A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section "Air Duct Accessories."
- B. Install ducts adjacent to fans to allow service and maintenance.
- C. Install line-sized piping from scroll drain connection, with trap with seal equal to 1.5 times specified static pressure, to nearest floor drain.
- D. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- E. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.03 FIELD QUALITY CONTROL

- A. Provide equipment with factory finish in accordance with the manufacturer's standards. Touch scratches and marks from handling and installation with masking enamel to match manufacturer's color.
- B. Where exhaust fans are required to have Heresite coating, have units factory finished with required number of coats prior to shipping to the job site.

END OF SECTION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Furnish and install air terminal units of constant volume fan powered type for use in variable volume central systems, including:
 - 1. Fan powered terminal units.
 - 2. Variable volume regulators.
 - 3. Integral heating coils.
 - 4. Integral damper motor operators.
 - 5. Integral controls.

1.02 REFERENCE STANDARDS

- A. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2024.
- B. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors; Current Edition, Including All Revisions.

1.03 RELATED SECTIONS

- A. Section 23 05 93 - System Testing, Adjusting, and Balancing for HVAC.
- B. Section 23 05 13 - Common Motor Requirements for HVAC.
- C. Section 23 07 16 - Commercial HVAC Insulation.
- D. Section 25 10 00 - Direct-Digital Control System for HVAC.
- E. Section 23 31 13 - Metal Ducts
- F. Section 23 33 00 - Ductwork Accessories.

1.04 REFERENCES

- A. NFPA 90A - Installation of Air Conditioning and Ventilation Systems.
- B. UL 181 - Factory-Made Air Ducts and Connectors.
- C. ADC 1062 - Air Distribution and Control Device Test Code.

1.05 CERTIFIED INDEPENDENT TESTING

- A. Prior to providing Submittals, the unit manufacturer is required to submit one fan powered terminal unit of each size to be used on this project. Unit shall be shipped to the TAB Contractor for testing in their test facility.
- B. Refer to Division 01 for test requirements.
- C. Units found to be in compliance with Specifications will be returned to unit manufacturer (at their expense) and may be submitted to the A/E for review.
- D. Units found not to be in compliance with Specifications will be returned to manufacturer (at their expense) for modification and/or re-design. All unit sizes will be re-tested by the TAB Contractor (at the expense of the unit manufacturer) until they are brought into total compliance with Specifications.

1.06 SUBMITTALS

- A. Indicate on product data the configuration, general assembly, and materials used in fabrication.
- B. Include manufacturer's installation instructions.
- C. Include certified factory test results indicating the noise criteria and sound power and performance characteristics for each unit. Include maximum and minimum cfm ratings at 0.50-inch WG with the unit on fully bypass or fully primary air with the fan running a medium speed, radiated sound power and discharge sound pressure with the fan on and unit on full bypass, fan horsepower and fan curve, pressure drop through the unit with heating coil and dampers on full

bypass. Include schedules listing discharge and radiated sound power level for each of second through sixth octave bands at inlet static pressures of one to 4 inch (101.6 mm) WG.

- D. Provide operation and maintenance manual. Include directions for resetting constant volume regulator.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Titus.
- B. Krueger.
- C. Nailor.
- D. Enviro-Tec.
- E. Price Industries.

2.02 MANUFACTURED UNITS

- A. Constant volume, fan powered, supply air control terminals for connection to single medium pressure duct, central air systems, with variable volume controls, hot water heating coils and fused disconnect switch.
- B. Identify each airflow unit with clearly marked identification label and airflow indicator. Include unit nominal air flow, maximum factory set air flow, minimum factory set air flow, and coil type on label.
- C. All Terminal Units shall be as manufactured by Price Fan Powered Ultra low noise series with 90 degrees inlet attenuator section and 36" discharge attenuator section. Even though specific manufacturers may be named herein, the material supplied by any approved manufacturer shall meet all of the provisions of this specification and sound levels of "Genesis" series without exception. Other acceptable manufacturers are Titus, Nailor and Krueger. All terminal units shall be provided with unit mounted transformers for fan motor and for controls as required and all protection devices per NEC requirements for a single point electrical connection

2.03 FABRICATION

- A. Casings. Minimum 22 gauge casing with 20 gauge bottom for sizes 6 and 8 and minimum 20 gauge casing with 18 gauge bottom for sizes 10 and above. Provide stiffeners and construct with sufficient rigidity to prevent vibration due to the action of turbulent air on the panel of the cabinet. Provide entire assembly capable of withstanding a maximum static pressure of 3.0 inches (76.2 mm) W.G. Units shall have full or divided removable bottom access panels with quarter-turn mechanical locks. Unit casing shall incorporate a minimum of four (one at each corner) galvanized steel angel hanger brackets to accept minimum 1/2" diameter all-thread rod and vibration isolator. Brackets shall be located as required to allow removal of ductwork, heating coil and air filter without removing unit and shall be a minimum of 1" above bottom of unit casing.
- B. Lining: Provide EPFI Engineered Polymer Foam Insulation or Cotton Liner meeting NFPA 90A 1 inch (25.4 mm) thick, 1.5 pounds per cubic foot density, or 3/4-inch-thick dual density, 4 pounds per cubic foot to 1.5 pounds per cubic foot requirements and UL 181 erosion requirements. Cover all exposed parts, such as braces, etc. in contact with exterior surfaces, to prevent condensation on the exterior of the cabinet and minimize both heat and sound transmission.
- C. Assembly: Air volume damper, fans and controls in single cabinet including inlet sound attenuator and renewable media filter in permanent frame.
- D. Plenum Air Inlets: Round/oval stub connections for duct attachment.
- E. Air Outlets: S and drive connections or 1-inch flange duct attachment.

- F. Mixing Sections: Multiple deflection baffles designed for mixing air with minimum pressure loss.
- G. Limit air leakage from cabinet to a maximum of three percent at 3.0 inches (76.2 mm) W.G. interior casing pressure.

2.04 VOLUME DAMPER

- A. Locate air volume damper assembly inside unit casing. Construct from extruded aluminum or 20 gauges galvanized steel components. Key damper blades into shaft with nylon fitted pivot points. Secure damper to independent damper rod with a minimum of four screws. Tap damper rod to allow the set-screw of the control arm to penetrate the damper rod.
- B. Provide automatic flow control assembly which combines spring rates matched for each volume regulator size with machined dashpot for stable operation.
- C. Mount automatic flow control assembly externally or provide access doors.
- D. Provide factory calibrated assembly consisting of damper and damper shaft extension for connection to externally mounted control actuator.
- E. Provide externally mounted electronic actuator to position damper, normally open, as indicated.

2.05 HEATING COILS

- A. Provide galvanized steel brackets supported in heavy gauge aluminized or galvanized steel frames. Construct in accordance with requirements of local authorities.
- B. Provide coil with capacities and number of equal capacities scheduled on Drawings.
- C. Provide hot water coil for operation with temperature control system.
- D. Heating coil shall be installed integral to unit housing with access doors and removable panels to allow removal of heating coil without disconnecting any ductwork from the terminal unit (No Exceptions). Heating coil section shall be insulated with the same insulation as the unit casing, as indicated above.
- E. Install at the unit discharge.

2.06 FAN ASSEMBLY

- A. Forward curved centrifugal type fan of metal construction. Motors must be GE ICM2+. DC and brushless motor design with a built-in inverter and a microprocessor-based motor controller. ECM -- Electronically Commutated Motor must be complete with and operated by a single-phase integrated controller/inverter that operates the wound stator and senses rotor position to electrically commutate the stator. All motors must be designed for synchronous rotation. Motor rotor must be permanent magnet type with near zero rotor losses. Motor must have built in soft start and soft speed change ramps. Motor must be able to be mounted with shaft in horizontal or vertical orientation. Motor must be permanently lubricated with ball bearings. Sleeve bearings will not be acceptable. Motor shall be direct coupled to the blower. Motor must maintain a minimum of 70% efficiency over its entire operating range.
- B. The manufacturer of the terminal units must set the fan cfm at the factory. Fan cfm must be constant within +/-5% regardless of changes in static whether upstream or downstream of the terminal unit after it is installed. Fan cfm is to be set with a potentiometer. Neither SCRs nor rheostats are acceptable means of setting fan cfm. A speed adjustment device must be included with the motor for field adjustment should construction or design changes become necessary.
- C. Provide a backdraft damper at the return air inlet to prevent backflow of primary air.
- D. Internally suspend and isolate fan/motor assembly from casing on rubber isolators to prevent noise and vibration transmission from the fan/motor assembly to the casing.
- E. Provide fan/motor assembly with a service life of 15 years.

- F. Provide capacitor or controls to allow rotation of the fan only in the proper direction regardless of condition of fan at start-up.
- G. Provide non-overloading type system with fan/motor assembly sized to supply all downstream static pressure requirements.

2.07 WIRING

- A. Factory-mount and wire controls. Mount electrical components in control box with removable cover. Incorporate single point electrical connection to power source.
- B. Factory mount transformer for control voltage on electric and electronic control units. Provide terminal strip in control box for field wiring of thermostat and power source.
- C. Factory wire fan to terminal strip.
- D. Provide factory installed fused disconnect switch.

2.08 CONTROLS

- A. Automatic Damper Operator:
 - 1. Operate: Air volume damper and automatic volume control.
 - 2. Electric Damper Operator: 24 volts (normally closed).
 - 3. Maximum Volume Controller and Probe: Electronic, with calibration pressure taps for high flow limited proportional variable air volume control.
 - 4. Velocity Reset Controller and Probe: Electronic, with calibration pressure taps for pressure independent proportional variable air volume control with means for pressure independent compensating for varying inlet static pressure, with minimum and maximum limits set at reset device, mounted in control box.
 - 5. Belimo Actuators & Valves only. No substitutions.

2.09 FAN POWERED UNIT CONTROLS

- A. Contain in NEMA-1 enclosure with access panel sealed from air flow and mounted on side of unit. The Terminal Equipment Controllers (TEC) shall be furnished by the BMCS System Manufacturer to the unit manufacturer for installation, wiring and testing at their factory. The factory mounted controls shall accomplish the following specified Sequence of Operation.
- B. Electronic Control Occupied Mode:
 - 1. When duct pressure is sensed indicating primary air system operating, and primary variable volume damper proportions air flow from BMCS and fan operates.
 - 2. As space sensor senses reduced cooling demand, volume damper closes. As cooling demand continues to fall, volume damper closes.
 - 3. Velocity reset primary air control (pressure independent) with maximum and minimum limits.
 - 4. Hi-limit device, factory set, limits maximum primary air flow
 - 5. As space sensor calls for less cooling, control system closes volume damper to minimum stop from central system primary air duct before heating is initiated. On sensing further need for heat, heating coil is energized.
- C. Electronic Control – Unoccupied Mode:
 - 1. DDC Control System cycles fan and controls at reduced temperature (day/night setback).

2.10 SOUND PERFORMANCE CRITERIA

- A. The following chart reflects maximum allowable discharge and radiated sound power level.

			MAXIMUM RADIATED
			SOUND POWER LEVEL, DB, AT BAND NO. AND CENTER
			FREQ.,

			(HZ)					
UNIT SIZE	INLET DIA.	FAN AND 100% PRIM ARY CFM	2	3	4	5	6	7
			125	250	500	1,000	2,000	4,000
	6	50 TO 250	56	52	45	37	33	31
	8	251 TO 500	55	50	45	38	34	33
	10	501 TO 800	57	49	46	39	35	32
	12	801 TO 1,150	63	56	53	45	41	40
	12	1,151 TO 1,400	61	56	50	43	38	36
	14	1,401 TO 1,600	67	60	53	46	43	42
	16	1,601 TO 2,050	68	61	55	49	45	44
			MAXIMUM DISCHARGE SOUND POWER LEVEL, DB, AT BAND NO. AND CENTER FREQ., HZ					
UNIT SIZE	INLET DIA.	FAN AND 100% PRIM ARY CFM	2	3	4	5	6	7
			125	250	500	1,000	2,000	4,000
	6	50 TO 250	66	60	54	49	45	40
	8	251 TO 500	65	60	55	50	47	44
	10	501 TO 800	66	57	57	54	50	49
	12	801 TO 1,150	74	64	64	63	59	59
	12	1,151 TO 1,400	70	63	62	62	58	58
	14	1,401 TO 1,600	72	65	66	66	62	60
	16	1,601 TO 2,050	74	67	68	69	66	65
NOTE: ALL RATINGS AT 1.0" WC INLET STATIC PRESSURE AND 0.5" W.C. DISCHARGE STATIC PRESSURE UP TO +2DB VARIATION ALLOWED.								

BASED UPON PRICE CONSTANT VOLUME WITH ECM (FOR EXTENDED RANGE OPERATION)

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide ceiling access doors or locate units above easily removable ceiling components.
- C. Support units individually from building structure. Do not support from adjacent ductwork. (No Exceptions.)
- D. Refer to Section 23 31 00 for connections to equipment.
- E. Install heating coils in accordance with detail on Drawings.
- F. Install disposable filters in accordance with Section 23 41 00.

END OF SECTION

PART 1 GENERAL

1.01 REFERENCE STANDARDS

- A. AMCA 500-L - Laboratory Methods of Testing Louvers for Rating; 2023.
- B. AMCA 550 - Test Method for High Velocity Wind Driven Rain Resistant Louvers; 2022.
- C. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus; 2026.
- D. ASTM D2794 - Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact); 1993 (Reapproved 2024).
- E. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2024.

1.02 WORK INCLUDED

- A. Diffusers.
- B. Diffuser boots.
- C. Registers/grilles.
- D. Louvers.

1.03 RELATED WORK

- A. Division 08 – Openings: Door Louvers
- B. Division 09 – Painting: Painting of Ductwork Visible Behind Outlets and Inlets
- C. Division 10 – Specialties: Metal Wall Louvers
- D. Section 23 05 00 – Common Work Results For HVAC
- E. Section 23 31 13 – Metal Ducts
- F. Section 23 33 00 – Ductwork Accessories

1.04 REFERENCES

- A. ADC 1062 - Certification, Rating and Test Manual.
- B. AMCA 500 - Test Method for Louvers, Dampers and Shutters.
- C. ANSI/NFPA 90A - Installation of Air Conditioning and Ventilating Systems.
- D. AHRI 650 - Air Outlets and Inlets.
- E. ASHRAE 70 - Method of Testing for Rating the Air Flow Performance of Outlets and Inlets.
- F. SMACNA - Low Pressure Duct Construction Standard.

1.05 QUALITY ASSURANCE

- A. Test and rate performance of air outlets and inlets in accordance with ADC Equipment Test Code 1062 and ASHRAE 70.
- B. Test and rate performance of louvers in accordance with AMCA 500 and AMCA 550.

1.06 REGULATORY REQUIREMENTS

- A. Conform to ANSI/NFPA 90A.

1.07 SUBMITTALS

- A. Submit product data under provisions of Division 01.
- B. Provide product data for items required for this project.
- C. Submit schedule of outlets and inlets indicating type, size, location, application, and noise level.
- D. Review requirements of outlets and inlets as to size, finish, and type of mounting prior to submitting product data and schedules of outlets and inlets.

- E. Submit manufacturer's installation instructions under provisions of Division 01.

PART 2 PRODUCTS

2.01 AIR SUPPLIES AND RETURNS

- A. Grilles, registers and ceiling outlets shall be as scheduled on the Drawings and shall be provided with sponge rubber or soft felt gaskets. If a manufacturer other than the one scheduled is used, the sizes shown on the Drawings shall be checked for performance, noise level, face velocity, throw, pressure drop, etc., before the submittal is made. Selections shall meet the manufacturer's own published data for the above performance criteria. The throw shall be such that the velocity at the end of the throw in the five foot occupancy zone will be not more than 50 FPM nor less than 25 FPM. Noise levels shall not exceed those published in the ASHRAE Guide for the type of space being served (NC level). Grilles, registers and ceiling outlets shall be Titus, Krueger or Metalaire.
- B. Locations of outlets on Drawings are approximate and shall be coordinated with other trades to make symmetrical patterns and shall be governed by the established pattern of the lighting fixtures or architectural reflected ceiling plan. Where called for on the schedules, the grilles, registers and ceiling outlets shall be provided with deflecting devices and manual damper. These shall be the standard product of the manufacturer, subject to review by the Architect, and equal to brand scheduled.

2.02 ACCEPTABLE MANUFACTURERS - CEILING DIFFUSERS

- A. Titus.
B. Krueger.
C. Metalaire.
D. Price.

2.03 RECTANGULAR CEILING DIFFUSERS

- A. Rectangular, stamped, multicore type all aluminum diffuser to discharge air in 360 degree pattern with sectorizing baffles where indicated; Model OMNI-AA manufactured by Titus.
- B. Provide mounting frame to accommodate installation in ceiling types shown on the Drawings.
- C. The finish shall be an anodic acrylic paint, baked at 315°F for 30 minutes. The pencil hardness must be HB to H. The paint must pass a 100-hour ASTM B117 Corrosive Environments Salt Spray Test without creepage, blistering or deterioration of film. The paint must pass a 250-hour ASTM D870 Water Immersion Test. The paint must also pass the ASTM D2794 Reverse Impact Cracking Test with a 50-inch pound force applied.
- D. The face panel shall be removable by means of four (4) hanger brackets. The exposed surface of the face panel shall be smooth, flat, and free of visible fasteners. The face panel shall project ¼ inch below the outside border of the diffuser backpan. Panels projecting more than ¼ inch below the outside border are not acceptable.
- E. The back of the face panel shall have an aerodynamically shaped, rolled edge to ensure a tight horizontal discharge pattern. A single metal thickness on the edges of the face panel will not be accepted. Ceiling diffusers with a 24 x 24-inch full face shall have no less than an 18 x 18-inch face panel size. Ceiling diffusers with a 12 x 12-inch full face shall have no less than a 9 x 9-inch face panel size.
- F. The backpan shall be one (1) piece precision die-stamped and shall include an integrally drawn inlet (welded-in inlets and corner joints are not acceptable). The diffuser backpan shall be constructed of 22-gauge aluminum. The diffuser neck shall have a minimum of 1¼-inch depth available for duct connection.

- G. Provide round volume damper and multi-louvered equalizing grid with damper adjustable from diffuser face. Optional round damper shall be constructed of heavy gauge steel. Damper must be operable from the face of the diffuser.
- H. Provide directional blow clips as required to restrict the discharge air in certain directions where shown on the Drawings.
- I. Provide R-6, foil-backed molded insulation blanket with 1-inch gap around the neck to install insulated flex duct.

2.04 ACCEPTABLE MANUFACTURERS - CEILING REGISTERS/GRILLES

- A. Titus.
- B. Krueger.
- C. Metalaire.
- D. Price.

2.05 CEILING GRID CORE RETURN REGISTERS/GRILLES

- A. Fixed grilles of 1/2 x 1/2 x 1/2 inch (12.7 mm) aluminum grid; Model 45F manufactured by Titus.
- B. Grilles must prevent line of sight when viewed directly from the face and provide a free area perpendicular to the 45 degree openings of at least 90%.
- C. Outer borders shall be constructed of heavy extruded aluminum with a thickness of 0.040-0.050 inch (1.27 mm) and shall have countersunk screw holes. Border width shall be 1¼ inches on all sides and shall be interlocked at the four corners and mechanically staked to form a rigid frame.
- D. The finish shall be an anodic acrylic paint, baked at 315°F for 30 minutes. The pencil hardness must be HB to H. The paint must pass a 100-hour ASTM B117 Corrosive Environments Salt Spray Test without creepage, blistering or deterioration of film. The paint must pass a 250-hour ASTM D870 Water Immersion Test. The paint must also pass the ASTM D2794 Reverse Impact Cracking Test with a 50-inch pound force applied.

2.06 CEILING GRID CORE EXHAUST REGISTERS/GRILLES

- A. Fixed grilles of 1/2 x 1/2 x 1/2 inch (12.7 mm) aluminum grid; Model 50F manufactured by Titus.
- B. Grilles must provide a free area of at least 90%.
- C. Outer borders shall be constructed of heavy extruded aluminum with a thickness of 0.040-0.050 inch (1.27 mm) and shall have countersunk screw holes. Border width shall be 1¼ inches on all sides and shall be interlocked at the four corners and mechanically staked to form a rigid frame.
- D. The finish shall be an anodic acrylic paint, baked at 315°F for 30 minutes. The pencil hardness must be HB to H. The paint must pass a 100-hour ASTM B117 Corrosive Environments Salt Spray Test without creepage, blistering or deterioration of film. The paint must pass a 250-hour ASTM D870 Water Immersion Test. The paint must also pass the ASTM D2794 Reverse Impact Cracking Test with a 50-inch pound force applied.
- E. Where not individually connected to exhaust fans, provide integral, gang-operated opposed blade dampers constructed of heavy gauge aluminum with removable key operator, operable from face.

2.07 ACCEPTABLE MANUFACTURERS - WALL REGISTERS/GRILLES

- A. Titus.
- B. Krueger.
- C. Metalaire.

D. Price.

2.08 WALL SUPPLY REGISTERS/GRILLES

- A. Streamlined and individually adjustable blades, 3/4 inch (19.05 mm) spacing with spring or other device to set blades, horizontal face, double deflection; Model 272FL manufactured by Titus.
- B. Fabricate 1 inch (25.4 mm) margin frame with concealed mounting and gasket.
- C. Fabricate of aluminum with 20 gauge minimum frames and 22 gauge minimum blades, aluminum with 20 gauge minimum frame, or aluminum extrusions, with factory baked enamel finish.
- D. Front blades shall be parallel to the long dimension. Blades shall be constructed of heavy duty aluminum and shall be contoured to a specifically designed airfoil cross-section to meet published performance data. Hollow blades are not acceptable. Blades must be solid. Blades shall be spaced 3/4-inch apart. Blades shall extend completely through the side frame on each side to ensure stability throughout the complete cfm operating range of the grille. Blades shall be individually adjustable without loosening or rattling and shall be securely held in place with tension wire.
- E. The finish shall be an anodic acrylic paint, baked at 315°F for 30 minutes. The pencil hardness must be HB to H. The paint must pass a 100-hour ASTM B117 Corrosive Environments Salt Spray Test without creepage, blistering or deterioration of film. The paint must pass a 250-hour ASTM D870 Water Immersion Test. The paint must also pass the ASTM D2794 Reverse Impact Cracking Test with a 50-inch pound force applied.
- F. Provide integral, gang-operated opposed blade dampers constructed of heavy gauge aluminum with removable key operator, operable from face.
- G. In gymnasiums, blades shall be front pivoted, welded in place or securely fastened to be immobile.

2.09 WALL EXHAUST AND RETURN REGISTERS/GRILLES

- A. Streamlined blades, depth of which exceeds 3/4 inch (19.05 mm) spacing parallel to the long dimension, with spring or other device to set blades, as scheduled; Model 350F manufactured by Titus.
- B. Fabricate 1-1/4 inch (6.35 mm) margin frame with concealed mounting. Minimum border thickness shall be 0.040-0.050 inch (1.27 mm).
- C. Fabricate of aluminum with 20 gauge minimum frames and 22 gauge minimum blades, aluminum with 20 gauge minimum frame, or aluminum extrusions, with factory baked enamel finish.
- D. Corners shall be welded with full penetration resistance welds. Sizes larger than 24 x 24 inches (609.6 mm) shall be constructed by using heavy aluminum extrusions and shall be interlocked at the four corners and mechanically staked to form a rigid frame. Screw holes shall be counter-sunk for a neat appearance.
- E. Deflection blades shall be contoured to a specifically designed and tested cross-section to meet published test performance data. Blades shall be firmly held in place by mullions from behind the grille and fixed in place by crimping or welding. Blade deflection angle shall be set at 35°.
- F. The finish shall be an anodic acrylic paint, baked at 315°F for 30 minutes. The pencil hardness must be HB to H. The paint must pass a 100-hour ASTM B117 Corrosive Environments Salt Spray Test without creepage, blistering or deterioration of film. The paint must pass a 250-hour ASTM D870 Water Immersion Test. The paint must also pass the ASTM D2794 Reverse Impact Cracking Test with a 50-inch pound force applied.

- G. Where not individually connected to exhaust fans, provide integral, gang-operated opposed blade dampers constructed of heavy gauge aluminum with removable key operator, operable from face.
- H. In gymnasiums, blades shall be front pivoted, welded in place, or securely fastened to be immobile.

2.10 ACCEPTABLE MANUFACTURERS - LOUVERS

- A. Titus.
- B. Krueger.
- C. Metalaire.
- D. Ruskin.
- E. Price.

2.11 LOUVERS

- A. Acceptable Product: Model EME6325D as manufactured by Ruskin Company or Engineer accepted equivalent.
- B. Listings:
 - 1. AMCA 540 Level E and AMCA 550 Listing with the Air Movement and Control Association Certified Ratings Program.
 - 2. Miami-Dade Acceptance Number: 15-0731.07.
 - 3. Florida Notice of Acceptance Number: FL 14156.1.
- C. Fabrication:
 - 1. Design: Extruded aluminum, stationary louvers with horizontally mounted drainable blades.
 - 2. Application: Miami-Dade Approved Product for use in open structures or installations where the enclosed space is designed to accommodate water infiltration (wet rooms). Miami-Dade County Protocols Compliance:
 - a. TAS-202 Uniform Static Air Pressure Test.
 - b. TAS-203 Cyclic Wind Pressure Test – Maximum Design Pressure Rating +/- 120 psf.
 - 3. Frame:
 - a. Frame Depth: 6 inches (152.4 mm), nominal.
 - b. Wall Thickness: 0.095 inch (2.41 mm), nominal.
 - c. Material: Extruded aluminum, Alloy 6063-T6.
 - 4. Blades:
 - a. Style: Vertically mounted.
 - b. Wall Thickness: 0.062 inch (1.57 mm), nominal.
 - c. Material: Extruded aluminum, Alloy 6063-T6.
 - 5. Sill: Sill Flashing: Formed aluminum, 0.080 inch (2.03 mm), upturned sides to prevent water leakage.
- D. Performance Data:
 - 1. Performance Ratings: AMCA licensed.
 - a. Based on testing 48 inches (1219.2 mm) x 48 inches size unit in accordance with AMCA 500-L.
 - 2. Free Area: 42 percent, nominal.
 - 3. Free Area Size: 6.66 sq feet (0.00717 sq cm).
 - 4. Maximum Recommended Air Flow through Free Area: 2,155 feet (65684.4 cm) per minute.
 - 5. Air Flow: 10,431 cubic feet per minute.
 - 6. Maximum Pressure Drop (Intake): 0.60 inches (15.24 mm) w.g.

7. Water Penetration: Beginning point of water penetration of 0.01 ounce per ft² of free area shall be above 1,250 feet (38100 cm) per minute free area velocity.
 8. Wind Load Rating: Maximum wind load of ± 150 PSF.
 9. AMCA 500-L Wind Driven Rain Performance: 99.9 percent effective at preventing water penetration through louver when tested at 50 miles (80.47 kilometers) per hour wind with 8 inches (203.2 mm) per hour rainfall and 2,155 feet (65684.4 cm) per minute airflow through the free area. Penetration Class 'A' with Discharge Class (Intake) '3' in accordance with AMCA 500-L Wind Driven Rain Test.
- E. Design Wind Criteria
1. Ultimate Wind Speed: 144 mph, 3-second gust
 2. Exposure: C
 3. Risk Category: III.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install items in accordance with manufacturers' instructions.
- B. Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement. Refer to Division 09.
- C. Install diffusers to ductwork with airtight connection.
- D. Provide balancing dampers on duct take-off to diffusers, and grilles and registers, regardless of whether dampers are specified as part of the diffuser, or grille and register assembly.
- E. Paint ductwork visible behind air outlets and inlets matte black. Refer to Division 09.
- F. All louvers located above ceilings are to have sheet metal plenums. Plenums are to be welded or soldered and shall be watertight. Plenum bottoms also shall slope to louver and the connection to the louver shall be watertight.

END OF SECTION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Disposable media filters.
- B. Filter frames.
- C. Filter gauges.

1.02 REFERENCE STANDARDS

- A. UL 900 - Standard for Air Filter Units; Current Edition, Including All Revisions.

1.03 RELATED SECTIONS

- A. Section 237300 – Indoor, Central-Station Air-Handling Units.
- B. Section 233100 – HVAC Ducts and Casings.
- C. Section 233600 – Air Terminal Units.
- D. Section 013300 Submittals.
- E. Section 01524 Construction Waste Management
- F. Section 01352 LEED Requirements
- G. Section 01611 Environmental Management
- H. Section 01570 Pollution Prevention and Control

1.04 REFERENCES

- A. UL 900 – Test Performance of Air Filter Units.
- B. ASHRAE 52 – Method of Testing Air Cleaning Devices used in General Ventilation for Removing Particulate Matter.

1.05 SUBMITTALS

- A. Include filter media, filter performance data, filter assembly and filter frames.
- B. Provide Operation and Maintenance manual.

1.06 QUALITY ASSURANCE

- A. Provide filter media that is UL 900 listed, Class 2, as approved by local authorities.
- B. Provide all filters as product of one manufacturer.
- C. Assemble filter components to form filter banks from products of one manufacturer.

1.07 EXTRA MATERIALS

- A. Provide one spare set of disposable media filters at project final acceptance for each piece of equipment requiring filters.

1.08 MAINTENANCE

- A. Provide twelve (12) months maintenance of all materials and equipment under this section. Cost of the twelve (12) month normal and preventive maintenance shall be included within this scope of work.

1.09 ENVIRONMENTAL REQUIREMENTS

- A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation. During construction, if the air units operate at any time, minimum MERV 13 filters shall be installed and kept clean.
- B. Provide two sets of belts and three sets of filters for each unit. One set of filters to be installed when unit is started up and shall be protected from construction debris with additional media

either at the first bank of filters, or covering each air intake (outside air and return air). Second set of filters to be installed when test and balance activities begin. At substantial completion shall inspect filters to determine if the third set should be installed or delivered to school operations personnel. Tag to identify associated unit.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. American Air Filter.
- B. Cam-Farr.
- C. Continental.

2.02 PANEL FILTERS

- A. All air filters shall be listed as (Class 1, Class 2) in accordance with Underwriters Laboratories, Inc., Building Materials Director requirements, except ultra-high efficiency filters, (HEPA or ULPA,) shall be manufactured of materials that are so listed by UL. All filters other than the ultrahigh efficiency type are to be rated in accordance with ASHRAE Test Standard 52-76 and performance characteristics are to be published in the manufacturer's literature. When specified performance characteristics are not published in the manufacturer's literature, the submittal data shall include certified documentation of performance by an approved independent test laboratory.
- B. Permanent, Washable: Viscous coated, high velocity filters. The net velocity through the filters shall not exceed 500 fpm. Filters shall be 2" (two inches) thick and the initial clean resistance to air flow shall not exceed 0.10" (one tenth inch) w.g. Filters shall be installed in side access or front access frames, as shown on the drawings. Filters in front access frames shall be furnished with lift handles. Furnish one complete set of spare filters for each system.
- C. Sectional, Renewable Media: Air filters shall be 2" (two inches) thick adhesive coated glass fiber media pads enclosed in sectional frames of not less than 16 (sixteen) gauge galvanized steel and equipped with a quick opening mechanism for changing filter media. The airflow capacity of the filters shall be based on a net filter face velocity not exceeding 350' (three hundred and fifty feet) per minute with an initial resistance no greater than 0.10" (one tenth inch) water gauge. When used as pre-filters, and mounted in the same holding frames as higher efficiency secondary air filters, the airflow capacity may be based on 500' per minute with an initial resistance not to exceed 0.17" water gauge. Filters shall have an average arresstance of not less than 70 to 75% when tested in accordance with ASHRAE Test Standard 52.
- D. Replaceable, Dry Type, Moderate Efficiency: Filters shall be of the pleated media, disposable type, 2" (two inches) deep in direction of airflow, Class 1 MERV 8. Each filter cell shall utilize a nonwoven, lofted cotton media with a net effective area of not less than 7.0 sq feet (0.00753 sq cm) of media per 1.0 sq feet (0.00108 sq cm) of filter face area, a media support grid, and enclosing high wet strength cell sides. The 96% free area welded wire support grid shall be continuously bonded to the leaving air face of the media to properly support the radially tapered, pleated media in the air stream through the life span of the filter. The media itself shall be cemented to the inside perimeter of the cell sides to prevent bypass of unfiltered air. Filter efficiency shall average not less than 25 to 30% when tested in accordance with ASHRAE Test Standard 52-76. Initial clean resistance to air flow shall not exceed 0.30" w.g. at 500 fpm filter face velocity. The 24" x 24" size shall be certified to have a dust holding capacity of not less than 265 grams of ASHRAE Test Dust when operated at 500 fpm to a final resistance of 1.0" w.g.
- E. Replaceable, Dry Type, Medium and/or High Efficiency (minimum MERV 13): Filters shall be 12" deep of the extended surface, supported pleat type. Each filter shall consist of high density, micro fine glass fiber media, media support grid, contour stabilizers, and enclosing galvanized

steel frame. Media shall be laminated to a nonwoven synthetic backing to form a lofted surface for maximum dust holding capacity. The edges of the media shall be continuously bonded to the internal surfaces of the galvanized steel frame to prevent bypass of unfiltered air. Filter efficiency shall average not less than 80 to 85% when tested in accordance with ASHRAE Test Standard 52-76. Filters shall be 24" x 24" x 12" deep with an initial clean resistance not to exceed 0.35 inches (8.89 mm) w.g. at 500 fpm face velocity. The filters shall be certified to have a dust holding capacity of not less than 700 grams of ASHRAE Test Dust when operated at 500 fpm face velocity to a final resistance of 1" w.g.

- F. Fabricate filter frames and supporting structures of 16 gauge galvanized steel or extruded aluminum T-section construction with necessary gasketing between frames and walls.
- G. Standard Sizes: Provide for interchangeability of filter media of other manufacturers; for panel filters, size for required installation of filter media minimum 2 inch (50.8 mm) thick; for extended surface and high efficiency particulate filters, provide for upstream mounting.
- H. Side Servicing Housing: Flanged for connection of ductwork, of reinforced 16 gauge galvanized steel; access doors with continuous gasketing and positive locking devices on both sides; extended aluminum tracks or channels for primary or secondary filters with positive sealing gaskets.

2.03 FILTER GAUGES

- A. Each individual filter or filter bank handling 2,000 cfm or more shall be equipped with a diaphragm actuated dial and pointer type gauge with zero adjustment capability. The range of the scale shall be no greater than 1" w.g. above the filter manufacturer's recommended final resistance for the type of filter to which the gauge is being applied. Each gauge shall be provided with an adjustable signal flag, two static pressure taps with compression fittings, two three way vent valves with compression fittings, two lengths of aluminum tubing, and a mounting plate with screws.
- B. Provide dry contact switch to indicate high-pressure limit (adjustable) for connection by others to FCMS system.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install air cleaning devices in accordance with manufacturer's instructions.
- B. Prevent passage of unfiltered air around filters with felt, rubber, or neoprene gaskets.
- C. Do not operate fan system until filters temporary or permanent are in place. Replace temporary filter used during construction.
- D. Install static pressure taps upstream and downstream of filters. Mount on outside of filter housing of filter plenum, in accessible position. Adjust and level.
- E. Provide differential pressure sensor at filter bank of each air handling unit.

END OF SECTION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Packaged Rooftop Air Conditioners with Energy Recovery

1.02 REFERENCE STANDARDS

- A. AMCA 99 - Standards Handbook; 2025.
- B. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus; 2026.
- C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D. UL 900 - Standard for Air Filter Units; Current Edition, Including All Revisions.

1.03 REFERENCES

- A. AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
- B. AMCA 99—Standards Handbook
- C. AMCA 500—Test Methods for Louver, Dampers, and Shutters.
- D. AHRI 340/360 - Unitary Large Equipment
- E. NEMA MG1—Motors and Generators
- F. National Electrical Code.
- G. NFPA 70—National Fire Protection Agency.
- H. SMACNA—HVAC Duct Construction Standards—Metal and Flexible.
- I. UL 900—Test Performance of Air Filter Units.

1.04 SUBMITTALS

- A. Shop Drawings: Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, electrical characteristics and connection requirements.
- B. Product Data:
 - 1. Provide literature that indicates dimensions, weights, capacities, ratings, fan performance, and electrical characteristics and connection requirements.
 - 2. Provide computer generated fan curves with specified operating point clearly plotted.
 - 3. Manufacturer's Installation Instructions.
- C. Wind-Restraint Details:
 - 1. Design Analysis: To support selection and arrangement of wind restraints. Include calculations of combined tensile and shear loads.
 - 2. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during wind events. Indicate association with vibration isolation devices.
 - 3. Coordinate vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Division 23 Sections for equipment mounted outdoors.
 - 4. Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

- D. Delegated-Design Submittal: For vibration isolation and wind-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified licensed professional engineer responsible for their preparation.
 - 1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, wind forces required to select vibration isolators, wind restraints, and for designing vibration isolation bases.
 - 2. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Division 23 Sections for equipment mounted outdoors.

1.05 OPERATION AND MAINTANENCE DATA

- A. Maintenance Data: Provide instructions for installation, maintenance and service

1.06 QUALIFICAITONS

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum five years documented experience, who issues complete catalog data on total product.
- B. Startup must be done by trained personnel experienced with rooftop equipment.
- C. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters and remote controls are in place, bearings lubricated, and manufacturers' installation instructions have been followed.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site.
- B. Accept products on site and inspect for damage.
- C. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Trane
- B. Carrier
- C. Daikin

2.02 GENERAL DESCRIPTION

- A. Furnish as shown on plans, either multi-zone VAV cooling unit(s) with supplemental heating or single-zone VAV heating and cooling unit(s) per plans. Unit performance and electrical characteristics shall be per the job schedule.
- B. Configuration: Fabricate as detailed on prints and drawings:
 - 1. Return plenum / economizer section
 - 2. Filter section
 - 3. Cooling coil section
 - 4. Hot-gas reheat section
 - 5. Energy wheel section (where indicated on schedule)
 - 6. Supply fan section
 - 7. Condensing unit section
- C. The complete unit shall be cETLus listed.
- D. The unit shall be ASHRAE 90.1-2021 compliant and labeled.

- E. Each unit shall be specifically designed for outdoor rooftop application and include a weatherproof cabinet. Each unit shall be completely factory assembled and shipped in one piece. Packaged units shall be shipped fully charged with R-454B Refrigerant and oil.
- F. The unit shall undergo a complete factory run test prior to shipment. The factory test shall include a refrigeration circuit run test, a unit control system operations checkout, a unit refrigerant leak test and a final unit inspection.
- G. All units shall have decals and tags to indicate caution areas and aid unit service. Unit nameplates shall be fixed to the main control panel door. Electrical wiring diagrams shall be attached to the control panels. Installation, operating and maintenance bulletins and start-up forms shall be supplied with each unit.
- H. Performance: All scheduled EER, IEER, capacities and face areas are minimum accepted values. All scheduled amps, kW, and HP are maximum accepted values that allow scheduled capacity to be met.
- I. Warranty: The manufacturer shall provide 12-month parts only warranty. Defective parts shall be repaired or replaced during the warranty period at no charge. The warranty period shall commence at startup or six months after shipment, whichever occurs first.

2.03 CABINET, CASING, AND FRAME

- A. Panel construction shall be double-wall construction for all panels. All floor panels shall have a solid galvanized steel inner liner on the air stream side of the unit to protect insulation during service and maintenance. Insulation shall be a minimum of 2" thick with an R-value of 13.0, and shall be 2 part injected foam. Panel design shall include no exposed insulation edges. Unit cabinet shall be designed to operate at total static pressures up to 5.0 inches (127 mm) w.g.
- B. Exterior surfaces shall be constructed of pre-painted galvanized steel for aesthetics and long term durability. Paint finish to include a base primer with a high quality, polyester resin topcoat of a neutral beige color. Finished panel surfaces to withstand a minimum 750-hour salt spray test in accordance with ASTM B117 standard for salt spray resistance.
- C. Service doors shall be provided on the fan section, filter section, control panel section, and heating vestibule in order to provide user access to unit components. All service access doors shall be mounted on multiple, stainless steel hinges and shall be secured by a latch system. Removable service panels secured by multiple mechanical fasteners are not acceptable.
- D. The unit base shall overhang the roof curb for positive water runoff and shall seat on the roof curb gasket to provide a positive, weathertight seal. Lifting brackets shall be provided on the unit base to accept cable or chain hooks for rigging the equipment.

2.04 OUTDOOR/RETURN AIR SECTION

- A. Unit shall be provided with an outdoor air economizer section. The economizer section shall include outdoor, return, and exhaust air dampers. The economizer operation shall be fully integral to the mechanical cooling and allow up to 100% of mechanical cooling if needed to maintain the cooling discharge air temperature. The outdoor air hood shall be factory installed and constructed from galvanized steel finished with the same durable paint finish as the main unit. The hood shall include moisture eliminator filters to drain water away from the entering air stream. The outside and return air dampers shall be sized to handle 100% of the supply air volume. The dampers shall be parallel blade design. Damper blades shall be gasketed with side seals to provide an air leakage rate of 1.5 cfm / square foot of damper area at 1" differential pressure in accordance with testing defined in AMCA 500. A barometric exhaust damper shall be provided to exhaust air out of the back of the unit. A bird screen shall be provided to prevent infiltration of rain and foreign materials. Exhaust damper blades shall be lined with vinyl gasketing on contact edges. Control of the dampers shall be by a factory installed direct coupled actuator. Damper actuator shall be of the modulating, spring return type. A comparative enthalpy control shall be provided to sense and compare enthalpy in both

the outdoor and return air streams to determine if outdoor air is suitable for "free" cooling. If outdoor air is suitable for "free" cooling, the outdoor air dampers shall modulate in response to the unit's temperature control system.

- B. Unit shall be provided with a 100% outdoor air hood. The 100% outdoor air hood shall allow outdoor air to enter from the back of the unit, at the draw-through filter section. The outdoor air hood shall be factory installed and constructed from galvanized steel finished with the same durable paint finish as the main unit. The hood shall include a bird screen to prevent infiltration of foreign materials and a rain lip to drain water away from the entering air stream.
- C. Aeon low leak dampers shall be provided. Damper blades shall be fully gasketed and side sealed and arranged vertically in the hood. Damper leakage shall be less than 1.5 CFM/Sq. Ft. of damper area at 1.0 inch (25.4 mm) static pressure differential. Leakage rate to be tested in accordance with AMCA Standard 500. Damper blades shall be operated from multiple sets of linkages mounted on the leaving face of the dampers. Control of the dampers shall be from a factory installed actuator.
- D. Control of the outdoor dampers shall be by a factory installed actuator. Damper actuator shall be of the modulating type. Damper to open when when supply fan starts, and close when supply fan stops.

2.05 ENERGY RECOVERY

- A. The rooftop unit shall be provided with an AHRI certified rotary wheel air-to-air heat exchanger in a cassette frame complete with seals, drive motor and drive belt. The energy recovery wheel shall be an integral part of the rooftop unit with unitary construction and does not require field assembly. Bolt-on energy recovery units that require field assembly and section to section gasketing and sealing are not acceptable.
- B. The wheel capacity, air pressure drop and effectiveness shall be AHRI certified per AHRI Standard 1060. Thermal performance shall be certified by the manufacturer in accordance with ASHRAE Standard 84, Method of Testing Air-to-Air Heat Exchangers and AHRI Standard 1060, Rating Air-to-Air Heat Exchangers for Energy Recovery Ventilation Equipment.
- C. The rooftop unit shall be designed with a track so the entire energy recovery wheel cassette can slide out from the rooftop unit to facilitate cleaning.
- D. The unit shall have 2" Merv 8 filters for the outdoor air before the wheel to help keep the wheel clean and reduce maintenance. Filter access shall be by a hinged access door with ¼ turn latches.
- E. The matrix design shall have channels to reduce cross contamination between the outdoor air and the exhaust air. The layers shall be effectively captured in aluminum and stainless steel segment frames that provide a rigid and self-supporting matrix. All diameter and perimeter seals shall be provided as part of the cassette assembly and shall be factory set. Drive belt(s) of stretch urethane shall be provided for wheel rim drive without the need for external tensioners or adjustment.
- F. The total energy recovery wheel shall be coated with silica gel desiccant permanently bonded without the use of binders or adhesives, which may degrade desiccant performance. The substrate shall be lightweight polymer and shall not degrade nor require additional coatings for application in marine or coastal environments. Coated segments shall be washable with detergent or alkaline coil cleaner and water. Desiccant shall not dissolve nor deliquesce in the presence of water or high humidity.
- G. Wheels shall be provided with removable energy transfer matrix. Wheel frame construction shall be a welded hub, spoke and rim assembly of stainless, plated and/or coated steel and shall be self-supporting without matrix segments in place. Segments shall be removable without the use of tools to facilitate maintenance and cleaning.

- H. Wheel bearings shall be selected to provide an L-10 life in excess of 400,000 hours. Rim shall be continuous rolled stainless steel. Wheels shall be connected to the shaft by means of taper lock hubs.
- I. The exhaust air fan shall be a direct drive SWSI plenum fan. The exhaust fan shall be sized for the airflow requirements per the construction schedule. The unit controller shall control the exhaust fan to maintain building pressure. A VFD shall be provided for the exhaust fan motor or the exhaust fan motor shall be an ECM motor. The rooftop unit shall have single point electrical power connection and shall be ETL listed.
- J. The control of the energy recovery wheel shall be an integral part of the rooftop unit's DDC controller. The DDC controller shall have visibility of the outdoor air temperature, leaving wheel temperature, return air temperature, and exhaust air temperature. These temperatures shall be displayed at the rooftop units DDC controller LCD display. All of these temperatures shall be made available through the BACnet interface.
- K. The rooftop unit with the energy recovery wheel shall incorporate the economizer operation. The energy recovery wheel shall have a bypass damper. When the unit is in the economizer mode of operation the energy recovery wheel shall stop and the bypass dampers shall be opened. The outdoor air shall be drawn through the bypass dampers to reduce the pressure drop of the outdoor airstream.
- L. The rooftop unit DDC controller shall provide frost control for the energy recovery wheel. When a frost condition is encountered the unit controller shall stop the wheel. When in the frost control mode the wheel shall be jogged periodically and not be allowed to stay in the stationary position.

2.06 EXHAUST FAN

- A. Exhaust fan shall be a single width, single inlet (SWSI) airfoil centrifugal fan. The fan wheel shall be Class II construction with aluminum fan blades that are continuously welded to the hub plate and end rim. The exhaust fan shall be a direct drive fan mounted to the motor shaft. Belts and sheaves are not acceptable due to the additional maintenance.
- B. The fan motor shall be a totally enclosed EC motor that is speed controlled by the rooftop unit controller. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase. Motors shall be premium efficiency.
- C. The unit DDC controller shall provide building static pressure control. The unit controller shall provide proportional control of the exhaust fans from 25% to 100% of the supply air fan designed airflow to maintain the adjustable building pressure setpoint. The field shall mount the required sensing tubing from the building to the factory mounted building static pressure sensor.

2.07 FILTERS

- A. Unit shall be provided with a draw-through filter section. The filter rack shall be designed to accept a 2" prefilter and a 4" final filter. The unit design shall have a hinged access door for the filter section. The manufacturer shall ship the rooftop unit with 2" MERV 8 construction filters. The contractor shall furnish and install, at building occupancy, the final set of filters per the contract documents.

2.08 COOLING COIL

- A. The indoor coil section shall be installed in a draw through configuration, upstream of the supply air fan. The coil section shall be complete with a factory piped cooling coil and an ASHRAE 62.1 compliant double sloped drain pan.

- B. The direct expansion (DX) cooling coils shall be fabricated of seamless high efficiency copper tubing that is mechanically expanded into high efficiency aluminum plate fins. Coils shall be a multi-row, staggered tube design with a minimum of three (3) rows. All cooling coils shall have an interlaced coil circuiting that keeps the full coil face active at all load conditions. All coils shall be factory leak tested with high pressure air under water.
- C. The cooling coil shall have an electronic controlled expansion valve. The unit controller shall control the expansion valve to maintain liquid subcooling and the superheat of the refrigerant system.
- D. The refrigerant suction lines shall be fully insulated from the expansion valve to the compressors.
- E. The drain pan shall be stainless steel and positively sloped. The slope of the drain pan shall be in two directions and comply with ASHRAE Standard 62.1. The drain pan shall have a minimum slope of 1/8" per foot to provide positive draining. The drain pan shall extend beyond the leaving side of the coil. The drain pan shall have a threaded drain connection extending through the unit base.

2.09 HOT GAS REHEAT

- A. Unit shall be equipped with a fully modulating hot gas reheat coil with hot gas coming from the unit condenser
- B. Hot gas reheat coil shall be a Micro Channel design. The aluminum tube shall be a micro channel design with high efficiency aluminum fins. Fins shall be brazed to the tubing for a direct bond. The capacity of the reheat coil shall allow for a 20°F temperature rise at all operating conditions.
- C. The modulating hot gas reheat systems shall allow for independent control of the cooling coil leaving air temperature and the reheat coil leaving air temperature. The cooling coil and reheat coil leaving air temperature setpoints shall be adjustable through the unit controller. During the dehumidification cycle the unit shall be capable of 100% of the cooling capacity. The hot gas reheat coil shall provide discharge temperature control within +/- 2°F.
- D. Each coil shall be factory leak tested with high-pressure air under water.

2.10 SUPPLY FAN

- A. Supply fan shall be a single width, single inlet (SWSI) airfoil centrifugal fan or direct drive plenum fan. The fan wheel shall be Class II construction with fan blades that are continuously welded to the hub plate and end rim. The supply fan shall be a direct drive fan mounted to the motor shaft. Belts and sheaves are not acceptable due to the additional maintenance.
- B. All fan assemblies shall employ solid steel fan shafts. Heavy-duty pillow block type, self-aligning, grease lubricated ball bearings shall be used. Bearings shall be sized to provide a L-50 life at 250,000 hours. The entire fan assembly shall be isolated from the fan bulkhead with a flexible collar and mounted on 1" spring isolators.
- C. All fan assemblies shall be statically and dynamically balanced at the factory, including a final trim balance, prior to shipment.
- D. Supply fan and motor assembly combinations larger than 5 hp shall be internally isolated on 1" deflection, spring isolators and include removable shipping tie downs.
- E. The motor shall be inverter duty T Frame and open drip proof. Overload protection and speed control is provided by the factory installed VFD and rooftop unit controller. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase. Motors shall be premium efficiency.
- F. The supply fan shall be capable of airflow modulation from 30% to 100% of the scheduled designed airflow. The fan shall not operate in a state of surge at any point within the modulation range.

2.11 VARIABLE AIR VOLUME CONTROL

- A. An electronic variable frequency drive shall be provided for the supply air fan. Each drive shall be factory installed out of the air stream in a conditioned cabinet. Drives shall meet UL Standard 95-5V. The completed unit assembly shall be listed by a recognized safety agency, such as ETL. Drives are to be accessible through a hinged door assembly. Mounting arrangements that expose drives to high temperature unfiltered ambient air are not acceptable.
- B. The unit manufacturer shall install all power and control wiring.
- C. The supply air fan drive output shall be controlled by the factory installed main unit control system and drive status and operating speed shall be monitored and displayed at the main unit control panel.

2.12 HEATING SECTION

- A. The rooftop unit shall include a gas heating coil section. Staged heating coil modules shall be factory installed downstream of the supply air fan in the heating section of the rooftop unit. The power supply for the unit shall be factory wired into the unit's main power block or disconnect switch.

2.13 CONDENSING SECTION

- A. Outdoor coils shall be cast aluminum, micro-channel coils. Plate fins shall be protected and brazed between adjoining flat tubes such that they shall not extend outside the tubes. A sub-cooling coil shall be an integral part of the main outdoor air coil. Each outdoor air coil shall be factory leak tested with high-pressure air under water.
- B. Fan motors shall be an ECM type motor for proportional control. The unit controller shall proportionally control the speed of the condenser fan motors to maintain the head pressure of the refrigerant circuit from ambient condition of 0~120°F. Mechanical cooling shall be provided to 0° F. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase.
- C. The condenser fan shall be low noise blade design. Fan blade design shall be a dynamic profile for low tip speed. Fan blade shall be of a composite material.
- D. The unit shall have scroll compressors. One of the compressors shall be an inverter compressor providing proportional control. The unit controller shall control the speed of the compressor to maintain the discharge air temperature. The inverter compressor shall have a separate oil pump and low oil safety protection.
- E. Pressure transducers shall be provided for the suction pressure and head pressure. Temperature sensor shall be provided for the suction temperature and the refrigerant discharge temperature of the compressors. All of the above devices shall be an input to the unit controller and the values be displayed at the unit controller.
- F. Each circuit shall be dehydrated and factory charged with R-410A Refrigerant and oil.

2.14 ELECTRICAL

- A. Unit wiring shall comply with NEC requirements and with all applicable UL standards. All electrical components shall be UL recognized where applicable. All wiring and electrical components provided with the unit shall be number and color-coded and labeled according to the electrical diagram provided for easy identification. The unit shall be provided with a factory wired weatherproof control panel. Unit shall have a single point power terminal block for main power connection. A terminal board shall be provided for low voltage control wiring. Branch short circuit protection, 115-volt control circuit transformer and fuse, system switches, and a high temperature sensor shall also be provided with the unit. Each compressor and condenser fan motor shall be furnished with contactors and inherent thermal overload protection. Supply

fan motors shall have contactors and external overload protection. Knockouts shall be provided in the bottom of the main control panels for field wiring entrance.

- B. A GFI receptacle shall be unit mounted that is field powered.
- C. A single non-fused disconnect switch shall be provided for disconnecting electrical power at the unit. Disconnect switches shall be mounted internally to the control panel and operated by an externally mounted handle.

2.15 CONTROLS

- A. Provide a complete integrated microprocessor based Direct Digital Control (DDC) system to control all unit functions including temperature control, scheduling, monitoring, unit safety protection, including compressor minimum run and minimum off times, and diagnostics. This system shall consist of all required temperature sensors, pressure sensors, controller and keypad/display operator interface. All MCBs and sensors shall be factory mounted, wired and tested.
- B. The stand-alone DDC controllers shall not be dependent on communications with any on-site or remote PC or master control panel for proper unit operation. The microprocessor shall maintain existing set points and operate stand alone if the unit loses either direct connect or network communications. The microprocessor memory shall be protected from voltage fluctuations as well as any extended power failures. All factory and user set schedules and control points shall be maintained in nonvolatile memory. No settings shall be lost, even during extended power shutdowns.
- C. The DDC control system shall permit starting and stopping of the unit locally or remotely. The control system shall be capable of providing a remote alarm indication. The unit control system shall provide for outside air damper actuation, emergency shutdown, remote heat enable/disable, remote cool enable/disable, heat indication, cool indication, and fan operation.
- D. All digital inputs and outputs shall be protected against damage from transients or incorrect voltages. All field wiring shall be terminated at a separate, clearly marked terminal strip.
- E. The DDC controller shall have a built-in time schedule. The schedule shall be programmable from the unit keypad interface. The schedule shall be maintained in nonvolatile memory to ensure that it is not lost during a power failure. There shall be one start/stop per day and a separate holiday schedule. The controller shall accept up to sixteen holidays each with up to a 5-day duration. Each unit shall also have the ability to accept a time schedule via BAS network communications.
- F. The keypad interface shall allow convenient navigation and access to all control functions. The unit keypad/display character format shall be 4 lines x 20 characters. All control settings shall be password protected against unauthorized changes. For ease of service, the display format shall be English language readout. Coded formats with look-up tables will not be accepted. The user interaction with the display shall provide the following information as a minimum:
 - 1. Return air temperature.
 - 2. Discharge air temperature.
 - 3. Outdoor air temperature.
 - 4. Space air temperature.
 - 5. Outdoor enthalpy, high/low.
 - 6. Compressor suction temperature and pressure
 - 7. Compressor head pressure and temperature
 - 8. Expansion valve position
 - 9. Condenser fan speed
 - 10. Inverter compressor speed
 - 11. Dirty filter indication.
 - 12. Airflow verification.

13. Cooling status.
 14. Control temperature (Changeover).
 15. VAV box output status.
 16. Cooling status/capacity.
 17. Unit status.
 18. All time schedules.
 19. Active alarms with time and date.
 20. Previous alarms with time and date.
 21. Optimal start
 22. Supply fan and exhaust fan speed.
 23. System operating hours.
 - a. Fan
 - b. Exhaust fan
 - c. Cooling
 - d. Individual compressor
 - e. Heating
 - f. Economizer
 - g. Tenant override
- G. The user interaction with the keypad shall provide the following:
1. Controls mode
 - a. Off manual
 - b. Auto
 - c. Heat/Cool
 - d. Cool only
 - e. Heat only
 - f. Fan only
 2. Occupancy mode
 - a. Auto
 - b. Occupied
 - c. Unoccupied
 - d. Tenant override
 3. Unit operation changeover control
 - a. Return air temperature
 - b. Space temperature
 - c. Network signal
 4. Cooling and heating change-over temperature with deadband
 5. Cooling discharge air temperature (DAT)
 6. Supply reset options
 - a. Return air temperature
 - b. Outdoor air temperature
 - c. Space temperature
 - d. Airflow (VAV)
 - e. Network signal
 - f. External (0-10 vdc)
 - g. External (0-20 mA)
 7. Temperature alarm limits
 - a. High supply air temperature
 - b. Low supply air temperature
 - c. High return air temperature
 8. Lockout control for compressors.

-
9. Compressor interstage timers
 10. Night setback and setup space temperature.
 11. Building static pressure.
 12. Economizer changeover
 - a. Enthalpy
 - b. Drybulb temperature
 13. Currently time and date
 14. Tenant override time
 15. Occupied/unoccupied time schedule
 16. One event schedule
 17. Holiday dates and duration
 18. Adjustable set points
 19. Service mode
 - a. Timers normal (all time delays normal)
 - b. Timers fast (all time delays 20 sec)
- H. If the unit is to be programmed with a night setback or setup function, an optional space sensor shall be provided. Space sensors shall be available to support field selectable features. Sensor options shall include:
- I. Zone sensor with tenant override switch
 - J. Zone sensor with tenant override switch plus heating and cooling set point adjustment. (Space Comfort Control systems only)
 - K. To increase the efficiency of the cooling system the DDC controller shall include a discharge air temperature reset program for part load operating conditions. The discharge air temperature shall be controlled between a minimum and a maximum discharge air temperature (DAT) based on one of the following inputs:
 1. Airflow
 2. Outside air temperature
 3. Space temperature
 4. Return air temperature
 5. External signal of 1-5 vdc
 6. External signal of 0-20 mA
 7. Network signal

2.16 ROOF CURB

- A. Wind restrained vibration isolation roof-curb rails are specified in Division 23 Section "Vibration and Wind Restraint Controls for HVAC Piping and Equipment."
- B. Wind Restraints: Metal brackets compatible with the curb and casing, painted to match RTU, used to anchor unit to the curb, and designed for loads at Project site. Comply with requirements in Division 23 Section "Vibration and Wind Restraint Controls for HVAC Piping and Equipment" for wind-load requirements.
- C. Ground mounted units shall be provided with manufacturer supplied 36" extended curb with supply / exhaust / return air plenum.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of RTUs.
- B. Examine roughing-in for RTUs to verify actual locations of piping and duct connections before equipment installation.

- C. Examine area for suitable conditions where RTUs will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Roof Curb: Install in accordance with manufacturer's written instructions. Coordinate attachment to structure with Project Structural Engineer.
- B. Install wind restraints according to manufacturer's written instructions. Wind restrained vibration isolation roof-curb rails are specified in Division 23 Section "Vibration and Wind Restraint Controls for HVAC Piping and Equipment."

3.03 CONNECTIONS

- A. Install condensate drain, minimum connection size, with trap terminate above grade at a permeable area near unit. Refer to plans for additional information.
- B. Install piping adjacent to RTUs to allow service and maintenance.
- C. Duct installation requirements are specified in other Division 23 Sections. Drawings indicate the general arrangement of ducts.

END OF SECTION

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Coordinate with Commissioning Requirements indicated in Section 019113. This Contractor is responsible to comply with all requirements for the above section.

1.02 SUMMARY

- A. Section Includes:
 - 1. Summary of Work.
 - 2. Submittals, Analysis and Device Schedules.
 - 3. Record Documents.
 - 4. Operating and Maintenance Manuals.
 - 5. General Electrical Product Requirements.
 - 6. General Electrical Installation Requirements.
 - 7. Electrical equipment coordination and installation.
 - 8. Sleeves for raceways and cables.
 - 9. Sleeve seals.
 - 10. Grout.
 - 11. Common electrical installation requirements.
- B. Provide all work required for complete electrical and ancillary system as indicated on the drawings and in these specifications. This may include, but is not necessarily limited to; panelboards, transformers, cabinets, motor controllers, circuit breakers, fuses, disconnect switches, surge suppression, fire alarm system, Lighting Control System, interior and exterior lighting, parking lot lighting, lamps, relay panels, contactors, controls, wiring devices, wire and cable, grounding and bonding, lightning protection, equipment wiring system, conduit, raceways, boxes, supporting devices, identification, fire stopping, testing, excavating, concrete equipment bases, concrete duct encasements, conduit sleeves and supports, anchors, vibration and sound isolation, access panels, record drawings, installation permits, inspections by governing authorities, electrical work of certain temporary facilities and services, cutting-and-patching work, utility connection coordination, start-up of electrical systems and equipment, training of Owner's operating personnel, operating and maintenance manuals, final cleaning of electrical and similar work.
- C. Except where otherwise indicated, electrical drawings prepared by Engineer (contract drawings) are diagrammatic in nature and may not show locations accurately for various components of electrical systems. It is the intention of the Construction Documents to establish the types and functions of the systems, but not to set forth each and every item essential to the functioning of any system. The Contractor shall make necessary changes or additions as may be reasonably inferred from the construction documents for a complete operating system as required and record these on the record documents at no cost to the Owner.
- D. Contractor shall visit site prior to submitting his proposal and become familiar with the conditions under which the Work is to be performed, and correlate site observations with the requirements of the Contract Documents. Errors, inconsistencies or omissions discovered shall be reported to the Architect/Engineer at once.
- E. All electrical products and installations shall comply with the latest additions of the following standards where applicable:
 - 1. ADA - AMERICANS WITH DISABILITIES ACT
 - 2. ANSI - AMERICAN NATIONAL STANDARDS INSTITUTE
 - 3. ASTM - AMERICAN SOCIETY FOR TESTING AND MATERIALS
 - 4. CBM - CERTIFIED BALLAST MANUFACTURERS

5. ETL - ELECTRICAL TESTING LABORATORIES
6. FM - FACTORY MUTUAL
7. ICEA - INSULATED CABLE ENGINEERS ASSOCIATION
8. IEEE - INSTITUTE OF ELECTRONICS AND ELECTRICAL ENGINEERS
9. NEC - NATIONAL ELECTRICAL CODE
10. NECA - NATIONAL ELECTRICAL CONTRACTORS ASSOCIATION
11. NEMA - NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION
12. NESC - NATIONAL ELECTRICAL SAFETY CODES
13. NFPA - NATIONAL FIRE PROTECTION ASSOCIATION
14. NETA - INTERNATIONAL ELECTRICAL TESTING ASSOCIATION
15. OSHA - OCCUPATIONAL SAFETY AND HEALTH ASSOCIATION
16. UBC - UNIFORM BUILDING CODE
17. IBC – INTERNATIONAL BUILDING CODE
18. ICC – INTERNATIONAL CODE COUNCIL
19. IECC – INTERNATIONAL ENERGY CONSERVATION CODE
20. ISO – INTERNATIONAL ORGANIZATION FOR STANDARDIZATIONUL
21. UNDERWRITERS LABORATORIES, INC.
22. TAS – TEXAS ACCESSIBILITY STANDARDS
23. STATE ENERGY CONSERVATION CODE
24. MUNICIPAL OR COUNTY CODES. In the event of conflicts between codes or standards, the more stringent requirements shall govern.

F. All work and materials shall be warranted as indicated in Division 1.

G. Contractor is responsible for filing and paying for all fees and obtaining necessary permits and certificates of inspection, and shall deliver all certificates of inspection to Owner, and include copies with maintenance manuals.

1.03 DEFINITIONS

A. NRTL: Nationally Recognized Testing Laboratory, including United Laboratories (UL) and Intertek (ETL).

1.04 REFERENCE STANDARDS

A. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2024.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

1.05 SUBMITTALS

A. General Submittal Requirements:

1. All submittals shall be in accordance with Division 1 requirements.
2. Submit number of copies indicated in Division 1 or 6 copies, whichever is greater.
3. Applicability: Wherever it is indicated that shop drawings, samples, manufacturer's brochure, certification, test, copy of standard operating instructions, manual, extra stock, or warranty is required, appropriate submittal is required regardless of whether it is specified as "submittal"; Engineer's decision shall be final.
4. Do not purchase equipment until submittals have been reviewed by Engineer with no exceptions taken.
5. Signed Commitments: Do not proceed with transfer of electrical systems to Owner for operation until warranties, performance certifications, maintenance agreements and similar commitments to be signed by Contractor and other entities have been executed and transmitted to Engineer (for Owner's records).
6. Response to Submittals: Where standard product data have been submitted in fulfillment of project requirements, it is recognized that submitter has already determined that

-
- products fulfill specified requirements, and that submittals are for engineer's information only, but will be returned without action where observed to be non-complying with requirements. Where uniquely prepared information is submitted, it is recognized to represent preparer's interpretation or solution to specified requirements, subject to Engineer's concurrence and appropriate action as indicated in Division 1.
7. Submittals shall be signed by the General Contractor and Subcontractor responsible for this work.
 8. The Engineer's review of submittals is solely for general conformance with the design concept. The Engineer's review does not relieve the Contractor from total responsibility for quantities, errors, omissions or compliance with the intent of the original contract documents. Review and approval by the Contractor is required before fabrication, shipment or installation.
- B. Substitutions: Electrical submittals are not opportunities for gaining acceptance of substitutions. Any variance from the contract documents shall be identified in accordance with Division 1 requirements. Substitutions will be reviewed only for those reason identified in Division 1 and only if the procedures identified in Division 1 are followed. Any variances from the contract documents in the submittals which are not identified by the Contractor in accordance with the procedures of Division 1 and subsequently not identified by the Engineer's review shall be corrected by the Contractor at no cost to the Owner. Substitution request would only be considered if product is equal or better than what listed. No substitution will be allowed for fire alarm system and any electrical products and equipment.
- C. Coordination Drawings: Prior to any submittals being reviewed, the Contractor shall provide the coordination drawings indicated in Division 1. In accordance with Division 1, the coordination drawings shall show work in and above ceilings and in mechanical and electrical rooms with horizontal and vertical dimensions to avoid interference with structural framing, ceilings, partitions and other services. The coordination drawings shall be to a scale of $1/4" = 1'-0"$ or larger. Coordination drawings in the buildings shall include but not be limited to all Electrical rooms with size and location, major electrical equipment and accessories, switchgear and clearances, HVAC ductworks in rooms, plumbing, air grilles, light fixtures, communications equipment, access panels, transformers, switchboards, panelboards, control panels, fire alarm equipment, code clearances for equipment, manufacturers required maintenance clearance for equipment, concrete equipment pads, exterior wall penetrations, foundation penetrations, and fire rated wall penetrations.
- D. Short Circuit Analysis: Prior to any electrical submittals being reviewed, the Contractor shall perform short-circuit analysis of the specified electrical power distribution system. This analysis shall include:
1. A calculation of the maximum RMS symmetrical three-phase short-circuit current available at each panel location in the electrical system. The results shall represent the highest short-circuit currents to which the equipment might be subjected under the reported system conditions. The short circuit currents shall be calculated with the aid of a computer. The Contractor shall obtain necessary information from the utility to do this prior to furnishing equipment and coordinate with manufacturer to meet the greater of minimum required rating and rating indicated on Drawings.
 2. Appropriate motor short-circuit contribution such that the calculated values will represent the highest short-circuit current to which the equipment will be subjected under fault conditions.
 3. A tabular computer printout of equipment supplied by the electrical ratings of the electrical equipment supplied by the electrical manufacturer, the calculated short-circuits currents, X/R ratios, and notes regarding the adequacy or inadequacy of the equipment.
 4. A computer printout of input circuit data including cable lengths, number of cables per phase, cable impedance values, insulation types, transformer impedances, X/R ratios and other circuit information as related to the short-circuit calculations.

-
5. A bus-to-bus computer printout listing the maximum available short-circuit current in RMS symmetrical amperes and the X/R ratio of the fault current. This printout shall have an accompanying printout explaining how to interpret the short-circuit results.
 6. A computer-generated system one-line diagram clearly identifying individual equipment buses, bus numbers used in short-circuit analysis, cable and bus connections between the equipment and calculated maximum short-circuit current at each bus location.
 7. A discussion section evaluating the adequacy or inadequacy of the equipment, with recommendations as required for improvements to the system.
 8. Any inadequacies shall be called to the attention of the engineer and recommendations made for improvements.
 9. Six (6) bound copies of the completed short-circuit analysis sealed by a Texas Licensed Professional Electrical Engineer shall be submitted for the Engineer to review.
- E. Protective Device Time-Current Coordination Analysis: Prior to any electrical equipment submittals being reviewed, the Contractor shall perform a protective device time-current coordination analysis of the specified electrical power distribution system. This analysis shall include:
1. A determination of settings, ratings, or types for the over-current protective devices supplied. Where necessary, an appropriate compromise shall be made between system protection and service continuity with:
 - a. System protection shall be more important than service continuity. The time current condition analysis shall be performed with the aid of a computer.
 2. Computer generated log-log plots containing the time current characteristics of over-current devices. A sufficient number of log-log plots shall be provided to indicate the degree of system protection and coordination. The log-log plots shall include transformer ANSI withstand point and inrush currents of transformers where appropriate. Series rated devices shall not be acceptable.
 3. Computer printouts to accompany the log-log plots containing descriptions for each of the devices shown on the plot, setting of the adjustable devices, device numbers to simplify locations of the devices on the system one-line diagram and short circuits where shown.
 4. A tabular computer printout of the suggested settings of the adjustable over-current protective devices, the equipment where the devices are located, the device number corresponding to the device on the system one-line diagram and the number of the time-current log-log graphs where they are illustrated.
 5. A computer generated system one-line diagram clearly identifying individual equipment buses, the bus numbers, the device numbers and the maximum available short-circuit at each bus which shall include short-circuit current motor contributions.
 6. A discussion section evaluating the degree of system protection and service continuity with over-current devices, with recommendations as required for increased protection or coordination.
 7. Any inadequacies shall be called to the attention of the engineer and recommendations made for improvements.
 8. Six bound copies of the completed protective device time-current coordination analysis for the engineer.
- F. Over-current Device Schedule: Prior to any electrical submittals being reviewed, Contractor shall provide a schedule for each piece of equipment required by Divisions 11, 14, 21, 22, 23, 25, 27, and 28 inch (711.2 mm) coordination with subcontractors providing equipment under these sections. Submittals shall reflect required coordination by having related Contractor's signatures on the submittals. This means that electrical requirement for chiller as an example, shall be coordinated by BOTH Electrical and Mechanical subcontractors, and Over-Current Device Schedule submitted shall be signed by both Contractors. For each piece of equipment actually supplied, the schedule shall indicate the full load amps (FLA), the minimum circuit amps (MCA), and the maximum over-current protection device (MOCPD). The schedule shall

also indicate if the equipment is required to be protected by fuses only, thermal magnetic breaker only, HACR breakers only or any combination thereof. It shall also indicate if the equipment requires single point or multiple point of connections and how the Contractor is proposing to meet the requirements if different than construction documents. It shall explicitly indicate the required number of conductors, disconnect switch sizes and numbers (if required), and acceptable conduit sizes and number. These modifications shall be reflected in the electrical equipment submittal. Required changes shall be made at no cost to the Owner.

- G. After the coordination drawings, short circuit analysis coordination analysis and over-current device schedule are submitted, the products in Division 26 shall be submitted in the groups identified below. By submitting shop drawings on the project, this Contractor is indicating that all necessary coordination has been completed and that the systems, products and equipment submitted can be installed in the building and will operate as specified and intended, in full coordination with all other trades. Submittals for each group will be returned without review unless all sections are included. Sections will not be reviewed separately. At the Engineer's discretion, when a re-submittal is required for one section, any other sections within each group may require re-submittal. Contractor shall expedite submittals and re-submittals as required to allow for the Engineer's review time specified in Division 1. The groups of equipment shall be divided as follows:

1. Raceways, Conductors and Miscellaneous Equipment
 - a. Fire stopping
 - b. Conduit
 - c. Raceways, Multi-outlet Assemblies, Wireways and Auxiliary Gutters
 - d. Wires and Cables
 - e. Outlet Boxes
 - f. Wiring Devices
 - g. Cabinets and Enclosures
 - h. Grounding and Bonding
 - i. Supporting Devices
 - j. Electrical Identification
 - k. Lightning Protection Systems
2. Distribution Equipment
 - a. Distribution Switchboards
 - b. Enclosed Switches
 - c. Dry Type Transformers
 - d. Distribution Panelboards
 - e. Branch Circuit Panelboards
 - f. Enclosed Motor Controllers
 - g. Motor Control Center
 - h. Variable Speed Drives
3. Electrical Controls
4. Lighting Fixtures
 - a. Interior and Building Lighting Fixtures
5. Specialty Systems
 - a. Transient Voltage Surge Suppression
 - b. Fire Alarm System
 - c. Intercom System
 - d. Cable TV System
 - e. Local sound reinforcement System
6. Testing
 - a. Field Electrical Testing

-
- H. Shop Drawings: Prepare electrical shop drawings to accurate scale except where diagrammatic representations are specifically indicated. Show clearance dimensions of critical locations, and show dimensions of spaces required for operation and maintenance of equipment. Show conduit layouts and wire/cable connections and other electrical service connections and show interfaces with other work, including structural support. Indicate by note, portions of electrical work shown on shop drawings which deviates from indication of work in contract documents, and explain reasons for deviations. Show how such deviations coordinate with interfacing deviations on shop drawings for other portions of work, currently or previously submitted. Show wiring diagrams, erection, setting, weights, capacities, speeds, outputs, consumption, efficiencies, voltages, amperages, hertz, phases, noise levels, etc.
- I. Samples: Engineer's review of required sample submittals will be limited to observation of general type, pattern, and finish; and will not include testing and inspection of submitted samples, except for those specifically indicated for that purpose in the contract documents. Compliance with specified requirements remains the exclusive responsibility of the Contractor.
- J. Manufacturer's Data: Where pre-printed data covers more than one distinct product, size, type, material, trim, accessory group or other variation, mark submitted copy with black pen to indicate which variations are to be provided. Delete or mark-out all portions or pre-printed data which are not applicable. Where operating ranges are shown, mark data to show portions of range required for project application. Expansion or elaboration of standard data to describe non-standard product must be processed as shop drawing data to describe non-standard product. For each product include manufacturer's production specifications, installation or fabrication instructions, nearest source of supply (including telephone number), sizes, weights, speeds, operating characteristics, ratings, conduit and wire/cable connection sizes and locations, statements of compliance with required standard and governing regulations (include manufacturer's signed statements if not covered in printed data), performance data (where applicable) and similar information needed to confirm compliance with requirements.
- K. Manufacturer's Certification: Each manufacturer is required to review the system design as related to the proper operation of his equipment, including electrical requirements, automatic controls, mechanical systems and equipment locations and related items. With shop drawings submit a letter from the manufacturer stating that his equipment will operate satisfactorily under the design conditions. The manufacturer's representative shall review the final installation at the site and submit a second letter stating that the equipment operates satisfactorily as installed. Furnish certification for the systems listed in each section of Division 26.
1. Test Reports: The Contractor for various sub-systems shall submit proposed testing procedure for their system, subject to review and approval and owner acceptance. The contract will not be declared to be substantially complete until the functional operation of the subsystems have been demonstrated and verified and reports have been provided, reviewed and accepted. The project will not be declared substantially complete until the following has taken place:
 2. The "As-Built" drawings have been submitted, reviewed, and accepted by OWNER CM-PA/Bond Office.
 3. The various systems have been commissioned and accepted. This will include the following systems:
 - a. Building Fire Alarm System
 - b. Clock System
 - c. Television Distribution System
 - d. Building Computer Network
 - e. Surveillance and Security System
 - f. Intercom/Telephone

- L. Submit test report signed and dated by firms performing test, and prepare in manner specified in standard or regulation governing test procedure as indicated. Provide notarized executions on test reports.
- M. Warranties: Refer to Division 1 for procedures and submittal requirements for warranties. Refer to individual equipment specifications for warranty requirements. A minimum of one-year warranty period is required for all materials and equipment. Warranty period starts upon first beneficial use or acceptance by OWNER whichever comes first.
 - 1. Provide complete warranty information for each item to include product or equipment to include date of beginning of warranty or bond; duration of warranty or bond; names, addresses and telephone numbers and procedures for filing a claim and obtaining warranty services.
 - 2. Where pre-printed and published warranty includes substantial deviation from required warranty (as judged by Engineer), product is automatically disqualified from use on project, except where manufacturer prepares and issues specific project, warranty on product, stating that it is in lieu of published warranty, and is executed by authorized officer, and complies with requirements.
- N. Load Current and Overload Relay Heater List: Compiled by Contractor after motors have been installed. Arrange to demonstrate selection of heaters to suit actual motor nameplate full load currents.

1.06 RECORD DOCUMENTS

- A. Prepare record documents in accordance with the requirements in Division 1. In addition to the requirements specified in Division 1, indicate installed conditions for:
 - 1. Major raceway systems, size and location, for both exterior and interior; locations of control devices; distribution and branch electrical circuitry; access panels; and fuse and circuit breaker size and arrangements.
 - 2. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
 - 3. Approved substitutions, Contract Modifications, and actual equipment and materials installed.
 - 4. Underground cabling and conduits both interior and exterior, drawn to scale and fully dimensioned.
 - 5. Work concealed behind or within other work, in a non-accessible arrangement.
 - 6. Mains and branches of wiring/cabling systems, with switchboards, panelboards, and control equipment and devices located and numbered with terminals and connections located, and with equipment requiring maintenance located.
 - 7. Grounding systems including primary, secondary and special.
- B. Execution: Each installer or other entity responsible for recording installed work shall record firm name, signature and date on each drawing so marked.
- C. Prior to transmittal of corrected drawings, obtain three (3) sets of blue-line prints of each drawing in each set, regardless of whether corrections were necessary, and include in transmittal (two (2) sets are for Owner's use, and one (1) is for Engineer's records).

1.07 OPERATING AND MAINTENANCE MANUALS

- A. Prepare maintenance manuals in accordance with Division 1. In addition to the requirements specified in Division 1, provide the following.
- B. Submit sets prior to final inspection, in electronic PDF format.
- C. Contents:
 - 1. Directory, listing names, addresses, and telephone numbers of Architect/Engineer, Contractor, Subcontractor, and major equipment suppliers.
 - 2. Operation and maintenance instructions, arranged by system.

3. Project documents and certificates.
4. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
5. Manufacturer's original printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions. (Copies are not acceptable).
6. Maintenance procedures for routine preventative maintenance and troubleshoot; disassembly, repair, and re-assembly; aligning and adjusting instructions.
7. Servicing instructions and lubrication charts and schedules.
8. Warranty information including any corrections made during submittals.
9. Replacement parts list.
10. List of tools and accessories needed for maintenance.

1.08 COORDINATION

- A. Coordinate arrangement, mounting, and support of electrical equipment:
 1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
 2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
 3. To allow right of way for piping and conduit installed at required slope.
 4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
- B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."
- D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

PART 2 PRODUCTS

2.01 GENERAL MANUFACTURER QUALIFICATION

- A. Production Experience: For all electrical equipment, manufacturer shall be firm with not less than five (5) years successful production experience. Experience means production of units similar to those required, as judged by Engineer. Comply with longer-period experience requirements specified in other Division 26 sections of these Specifications. Product shall be new and design for quiet, vibration free operation.

2.02 GENREAL ELECTRICAL PRODUCT REQUIREMENTS

- A. Standard Products: Provide not less (quality) than manufacturer's standard products as specified by published product data. Do not assume that available off-the-shelf condition of product complies with requirements; as example, specific finish or color may be required.
- B. Unencumbered Purchases: Avoid purchases and use of products which are encumbered with questionable title transfers, patent rights, trade union restrictions, code compliance, non-listings as "approved products" for compliance with governing regulations, duties due, embargoes and similar possible encumbrances, claims or seller's interest.
 1. Purchasing: Do not purchase specific electrical materials and equipment for project until completion of submittals.

- C. Condition of Products: Except as otherwise indicated, provide new electrical products, free of defects and harmful deterioration at time of installation. Do not use units, which have been subjected to destructive testing, or other high-limits testing except where pre-tested products are specified. Comply with Division 1 requirements for exposure or visual display limitations against trademarks and manufacturer's names. Provide each product complete with trim, accessories, finish, guards, safety devices and similar components specified or recognized as integral parts of products, or required by governing regulations.
- D. Assembly and Testing: To greatest extent possible and unless otherwise indicated, complete fabrication, assembly, finishing and testing of products prior to delivery to project. Notify Engineer not less than one week in advance of pre-installation testing to be performed in response to project requirements. Engineer reserves right to be present at tests of electrical products; however, neither their absence nor presence relieves the Contractor of responsibility for compliance with requirements.
- E. Uniformity: Where multiple units of generic product are required for single major system of electrical work, e.g., cable trays, lighting systems, provide identical products by same manufacturer, without variations.
 - 1. Limitations: Product/manufacturer uniformity does not apply to conduit and fittings, 600V electrical wire, sheet metal, steel bar stock, welding rods, solder, factory applied paint between different systems, fasteners, motors for unlike equipment units, and similar items used in work, and except as otherwise indicated.
- F. Product Compatibility, Options: Where more than one product selection is specified, selections are Purchaser's or Installer's options, except do not provide products which are not compatible with previously purchased or installed products which must interface with selections. Provide electrical adaptations as needed for interfacing of selected products in work.
- G. Quality Assurance: Provide products listed by and installed in accordance with all references in each section under quality assurance any other applicable requirements.
- H. Elevation Requirements: Electrical equipment provided shall perform at mean elevation of 1000 feet (30480 cm) above sea level.
- I. Listing: Provide products that are listed by a NRTL.

2.03 SLEEVES FOR RACEWAYS AND CABLES

- A. Retain one of first two paragraphs below for penetrations through exterior walls above and below grade.
- B. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- C. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral water-stop, unless otherwise indicated.
- D. Sleeves for Rectangular Openings: Galvanized sheet steel.
 - 1. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side more than 16 inches (406.4 mm), thickness shall be 0.052 inch (1.32 mm).
 - b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches (1270 mm) and 1 or more sides equal to, or more than, 16 inches (406.4 mm), thickness shall be 0.138 inch (3.51 mm).

2.04 SLEEVE SEALS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

2.05 GROUT

- A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, non-staining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 EXECUTION

3.01 GENERAL ELECTRICAL INSTALLATIONS

- A. The Contractor shall provide all necessary items for a complete operating system.
- B. Provide all electrical systems required by and in accordance with Division 26.
- C. Perform work for other divisions as required for electrical installations or coordinate such work with other trades which includes but is not necessarily limited to:
 - 1. Division 1: Cutting and Patching, Temporary Controls, Submittals, Facility Start-up, Contract Close Out, Record Documents, etc.
 - 2. Division 2: Trenching, Backfilling, Compaction, Demolition, etc.
 - 3. Division 3: Concrete Formwork.
 - 4. Division 5: Metal Fabrications.
 - 5. Division 6: Rough Carpentry.
 - 6. Division 7: Joint Sealers and Fire Stopping
 - 7. Division 8: Electric Door Hardware and Access Doors
 - a. Deviation: Contractor is encouraged to coordinate and combine electrical access with mechanical access, and has the option to not add electrical access panels if acceptable coordination can be achieved.
 - 8. Division 9 - Painting: In addition to Division 9, paint electrical equipment factory applied paint surfaces damaged during installation with paint purchased from equipment manufacturer to match each damaged surface.
 - 9. Divisions 11 and 13: Laboratory Furniture, Electronic Systems, Intercoms, etc.
 - 10. Division 15 for motors, controls, accessories, and connections.
- D. Verify all dimensions by field measurements.
- E. Arrange for chases, sleeve, slots, and openings in other building components during progress of construction, to allow for electrical installations.
- F. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
- G. Where mounting heights or locations are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom and working clearances possible, but not less than required by Code.
- H. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings and manufacturer's instructions, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect.
- I. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
- J. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
- K. Install J-boxes for all other equipment requiring access or maintenance, which are concealed behind surfaces so that these devices can be serviced from the access panels. Where

practical, group J-boxes and equipment so that they can be accessed from the same panel or door. If additional panels are needed, panels must be submitted for approval.

- L. Cut, remove and legally dispose of selected electrical equipment, components, and materials, including but not limited to removal of electrical items indicated to be removed and items made obsolete by the new work.
- M. The A/E reserves the right to make relocations up to 6 feet (182.88 cm) of outlets, boxes, cabinets, lighting, etc. before finished rough-in at no cost to the Owner.
- N. Contractor shall notify design prime consultant and associated owner representative when he requests an inspection by the City Inspector.

3.02 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATIONS

- A. Comply with NECA 1.
- B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
- C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
- D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
- E. Right of Way: Give to piping systems installed at a required slope.

3.03 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- E. Cut sleeves to length for mounting flush with both surfaces of walls.
- F. Extend sleeves installed in floors 2 inches (50.8 mm) above finished floor level.
- G. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable, unless indicated otherwise.
- H. Seal space outside of sleeves with grout for penetrations of concrete and masonry
 - 1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.
- I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants".
- J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."
- K. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

- L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

3.04 SLEEVE-SEAL INSTALLATION

- A. Install to seal exterior wall penetrations.
- B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.05 FIRESTOPPING

- A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

3.06 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Protection and Identification: Deliver products to project properly identified with names, model numbers, types, grades, compliance labels and similar information needed for distinct identification; adequately packaged or protected to prevent deterioration during shipment, storage and handling. Store in dry, well ventilated, indoor space, except where prepared and protected by manufacturer specifically for exterior storage.

3.07 DAMAGED EQUIPMENT

- A. The following will be rejected (even after final installation) and must be replaced with same as original at no cost to Owner:
 - 1. Dented, deformed, stepped-on, or otherwise physically damaged enclosures.
 - 2. Stripped cover plate screws and the holes they screw into.
 - 3. Door hinges that do not operate smoothly.
- B. The following will require field repair to original condition:
 - 1. Minor scratches to equipment enclosure finishes.

3.08 TEMPORARY WIRING

- A. The electrical Contractor shall arrange for and provide all necessary equipment, outlets, temporary lights, metering and communications as required during the construction period for temporary electrical service to the project.
- B. It shall be the responsibility of the electrical Contractor to consult with all other trades on the project in order to determine the voltage of temporary electrical service required to operate the construction equipment to be employed and to provide such services to the project.
- C. It shall be the responsibility of the electrical Contractor to make all arrangements for, and to furnish and install, any and all temporary wiring, switches, and structures which may be required to maintain service continuity during the entire construction period. Temporary power and lights shall be UL listed and shall include a ground wire, a guard and a proper means of support.
- D. All temporary installations shall be performed in accordance with the current edition of the National Electrical Code. All machinery and equipment powered by electricity shall have effective electrical equipment grounding provided with all electrical circuits.

3.09 UTILITIES

- A. This Contractor shall examine the site and shall verify, to his own satisfaction, the location and elevation of all utilities, and shall adequately inform himself as to their relation to the work before entering into a contract.
- B. Existing utility lines shown within the scope of this project to be abandoned or removed shall be performed as directed by the Owner, and/or utility companies.
- C. Existing utility lines not shown on the drawings but encountered during construction shall be protected, relocated or capped as directed by the Owner, and/or utility companies. All precautions shall be exercised to prevent damage to existing lines not shown, but should work become necessary, it must be authorized prior to execution except in an emergency situation.
- D. Before beginning excavations of any nature whatsoever, the Contractor shall make an attempt to locate all underground utilities of every nature occurring within the bounds of the area to be excavated. The Contractor shall then proceed with caution in his excavation work so that no utility shall be damaged with a resultant loss of service.
- E. Should any damage result to any utility through the Contractor's negligence or failure to comply with the above directive, he will be liable for such damage and for all expense incurred in the expeditious repair or replacement of such damaged utilities.
- F. Repair of damaged utilities shall be to a condition equal to or better than the adjacent undamaged portion of such utility and to the complete satisfaction of the Owner and/or utility companies.

3.10 EXCAVATION

- A. The Contractor shall perform all excavation of every description and of whatever substances encountered, to the depths indicated and/or required for the installation of all portions of the utilities systems. All excavated materials not required for fill or backfill shall be removed. All excavation shall be made by open cut. The banks of trenches shall be kept as nearly vertical as practicable and where required shall be properly shored and braced. Trenches shall be at least 12" wider and not more than 16" wider than the outside diameter of the conduit, and shall be excavated true to line so that a clear space greater than 6" and less than 8" in width is provided on each side of the conduit or duct bank.
- B. Except at locations where the excavation of rock from bottom of trenches is required, care shall be taken not to excavate below the depths indicated. Where rock excavation is required, the rock shall be excavated to a minimum over-depth of 4" below the trench depths indicated on the drawings or as specified. The over-depth rock excavation shall be back-filled with loose, moist earth and thoroughly tamped.
- C. Whenever wet or otherwise unstable soil that is incapable of supporting the conduit duct bank, pole base or pad is encountered in the trench bottom, such soil shall be removed to a depth required. The trench bottom shall be filled with coarse sand, fine gravel, or other suitable material.
- D. Backfill with earth under pole bases, pads or other buried structures will not be permitted, and any unauthorized excess excavation below the levels indicated for foundation of such structures shall be filled with sand, gravel or concrete at the expense of the Contractor.
- E. All grading in the vicinity of excavations shall be controlled to prevent surface ground water from flowing into the excavations. Any water accumulated in the excavations shall be removed by pumping or by other approved method. During excavation, material suitable for backfilling shall be stacked in an orderly manner a sufficient distance back from the edges of trenches to avoid overloading and to prevent slides or cave-ins.

3.11 BACK-FILLING

- A. Trenches shall not be back filled until all required tests are performed and until the utilities systems as installed conform to the requirements specified.
- B. Trenches shall be carefully back filled with the excavated materials approved for back filling. This material shall consist of earth, loam, sandy clay, sand and gravel, soft shale, or other approved materials, free from large clods of earth or stones, deposited in thoroughly and carefully tamped 6" layers, until the conduit has a cover as specified. Broken rock, broken concrete or pavement, and large boulders shall not be used as backfill material.
- C. Settling the backfill with water will be permissible and will be a requirement when so directed.
- D. Any trenches across roadways or other areas to be paved shall be back filled with flowable fill (CLSM) or approved equal (ashes combined with concrete) in such manner as to permit the rolling and compaction of the filled trench. Together with the adjoining earth, shall provide required bearing value so that paving of the area can proceed immediately after the backfilling is completed.

3.12 CLOSEOUT PROCEDURES

- A. General Coordination: Refer to Division 01 sections and individual Specification sections for coordination of electrical closeout work with variable loads on electrical system. Coordinate taking of final photographs (if any) with electrical closeout, so that maximum detail of work as finally accepted is shown. Sequence closeout procedures properly, so that work will not be endangered or damaged, and so that every required performance will be fully tested and demonstrated.
- B. System Performance Test Runs: Coordinate test runs of electrical systems with test runs of equipment served thereby (heating, air conditioning, plumbing, etc.). Check each item in each system to determine that it is set for proper operation. With Owner's Representative and Engineer present, operate each system in test run of appropriate duration to demonstrate compliance with performance requirements. During or following test runs, make final corrections or adjustments of systems to refine and improve performances where possible, including noise and vibration reductions, elimination of hazards, better response of controls, signals and alarms, and similar system performance improvements. Provide testing or inspection devices as may be reasonably requested for Engineer's observation of actual system performances. Demonstrate that controls and items requiring service or maintenance are accessible.
- C. Cleaning and Lubrication: After final performance test run of each electrical system, clean system both externally and internally. Comply with manufacturer's instructions for lubrication of both power and hand-operated equipment, and remove excess lubrication. Touch-up minor damage to factory-painted finishes and other painting specified as electrical work; refinish work where damage is extensive.
- D. General Operating Instructions: In addition to specific training of Owner's operating personnel specified in individual Division 26 work sections, and in addition to preparation of written operating instructions and compiled maintenance manuals specified in Division-26 Sections and elsewhere in these specifications, provide general operating instructions for each operational system and equipment item of electrical work. Coordinate instructions with instructions for mechanical work, elevators and other equipment where associated with electrical systems or equipment.
 - 1. Describe each basic electrical system and functioning of its control system.
 - 2. Explain identification system, mimic diagrams, signals, actuators, sensors, alarms, telecommunication systems, and similar audio/visual provisions.
 - 3. Describe interfaces with mechanical equipment, including interlocks, sequencing, start-up, shut down, emergency, safety, system failure, security and similar provisions.

4. Outline basic maintenance procedures and major equipment turnaround requirements, including adjustments to optimize output and efficiency of electrical system.
 5. Display and conduct "thumb-through" explanation of maintenance manuals, record drawings, spare part inventory, storage of extra materials, meter readings and similar service items.
- E. Construction Equipment: After completion of performance testing and Owner's operating instructions and demonstrations, remove installer's tools, test facilities, construction equipment and similar devices and materials used in execution of work but not incorporated in work.
- F. Security and Protection: During electrical work closeout phase, meet with Owner's operating representative frequently (daily where necessary) and agree upon status of operational responsibility for electrical systems (including securing provisions to prevent unauthorized operations, and including protective measures to ensure that systems are not neglected or misused).

PART 4 CONTINUED SYSTEM OPERATIONS

- 4.01 ACCEPTANCE AND CONTINUED SERVICES: COORDINATE OWNER'S TAKE-OVER OF ELECTRICAL SYSTEMS WITH TAKE-OVER OF MECHANICAL SYSTEMS, INCLUDING THE PROVISION OF SKILLED ELECTRICAL OPERATING AND MAINTENANCE PERSONNEL UNTIL TIME OWNER'S PERSONNEL TAKE OVER OPERATION OF ENTIRE MECHANICAL AND ELECTRICAL PLANT. CONTRACTOR SHALL CONTINUE CONSULTATION AND SERVICES (BEYOND TAKE-OVER DATE) FOR ELECTRICAL SYSTEMS, MATCHING REQUIRED CONTINUED SERVICES ON ASSOCIATED MECHANICAL SYSTEMS AND EQUIPMENT.

END OF SECTION

26 05 19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

3.01 REFERENCE STANDARDS

- A. 29 CFR 1910 - Occupational Safety and Health Standards; Current Edition.
- B. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2024.
- C. NEMA WC 70 - Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy; 2021.
- D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- E. UL 13 - Power-Limited Circuit Cables; Current Edition, Including All Revisions.
- F. UL 1666 - Standard Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts; Current Edition, Including All Revisions.
- G. UL 1685 - Standard for Safety Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables; Current Edition, Including All Revisions.

3.02 RELATED DOCUMENTS

DRAWINGS AND GENERAL PROVISIONS OF THE CONTRACT, INCLUDING GENERAL AND SUPPLEMENTARY CONDITIONS AND DIVISION 01 SPECIFICATION SECTIONS, APPLY TO THIS SECTION.

SUMMARY

THIS SECTION INCLUDES THE FOLLOWING:

BUILDING WIRES AND CABLES RATED 600V AND LESS.

CONNECTORS, SPLICES, AND TERMINATIONS RATED 600V AND LESS.

SLEEVES AND SLEEVE SEALS FOR CABLES.

RELATED SECTIONS INCLUDE THE FOLLOWING:

LIST BELOW ONLY PRODUCTS AND EQUIPMENT THAT THE READER MIGHT EXPECT TO FIND IN THIS SECTION BUT ARE SPECIFIED ELSEWHERE.

DIVISION 27.

DEFINITIONS

RETAIN ABBREVIATIONS THAT REMAIN AFTER THIS SECTION HAS BEEN EDITED.

EPDM: ETHYLENE-PROPYLENE-DIENETERPOLYMER RUBBER.

NBR: ACRYLONITRILE-BUTADIENE RUBBER.

MCM: THOUSAND CIRCULAR-MILS.

SUBMITTALS

PRODUCT DATA: FOR EACH TYPE OF PRODUCT INDICATED.

COORDINATE PARAGRAPH BELOW WITH QUALIFICATION REQUIREMENTS IN DIVISION 01 SECTION "QUALITY REQUIREMENTS" AND AS SUPPLEMENTED IN "QUALITY ASSURANCE" ARTICLE.

QUALIFICATION DATA: FOR TESTING AGENCY.

RETAIN PARAGRAPH BELOW IF CONTRACTOR IS RESPONSIBLE FOR FIELD QUALITY-CONTROL TESTING.

FIELD QUALITY-CONTROL TEST REPORTS.

QUALITY ASSURANCE

RETAIN FIRST PARAGRAPH AND SUBPARAGRAPH BELOW IF CONTRACTOR IS REQUIRED TO PROVIDE SERVICES OF AN INDEPENDENT TESTING AGENCY IN PART 3 "FIELD QUALITY CONTROL" ARTICLE. QUALIFICATION REQUIREMENTS SUPPLEMENT THOSE SPECIFIED IN DIVISION 01 SECTION "QUALITY REQUIREMENTS", WHICH ALSO INCLUDES THE DEFINITION FOR NRTL.

TESTING AGENCY QUALIFICATIONS: AN INDEPENDENT AGENCY, WITH THE EXPERIENCE AND CAPABILITY TO CONDUCT THE TESTING INDICATED, THAT IS A MEMBER COMPANY OF THE INTERNATIONAL ELECTRICAL TESTING ASSOCIATION OR IS A NATIONALLY RECOGNIZED TESTING LABORATORY (NRTL) AS DEFINED BY OSHA IN 29 CFR 1910.7, AND THAT IS ACCEPTABLE TO AUTHORITIES HAVING JURISDICTION.

TESTING AGENCY'S FIELD SUPERVISOR: PERSON CURRENTLY CERTIFIED BY THE INTERNATIONAL ELECTRICAL TESTING ASSOCIATION OR THE NATIONAL INSTITUTE FOR CERTIFICATION IN ENGINEERING TECHNOLOGIES TO SUPERVISE ON-SITE TESTING SPECIFIED IN PART 3.

ELECTRICAL COMPONENTS, DEVICES, AND ACCESSORIES: LISTED AND LABELED AS DEFINED IN NFPA 70, ARTICLE 100, BY A TESTING AGENCY ACCEPTABLE TO AUTHORITIES HAVING JURISDICTION, AND MARKED FOR INTENDED USE.

COMPLY WITH NFPA 70.

UL COMPLIANCE: PROVIDE COMPONENTS WHICH ARE LISTED AND LABELED BY UL UNDER THE FOLLOWING STANDARDS.

UL STD. 83 - THERMOPLASTIC-INSULATED WIRES AND CABLES.

UL STD. 4 - ARMORED CABLE

UL STD. 1569 - METAL-CLAD CABLES

UL STD. 486A - WIRE CONNECTORS AND SOLDERING LUGS FOR USE WITH COPPER CONDUCTORS.

UL 13 - POWER LIMITED CIRCUIT CABLES.

UL 1666 - TEST FOR FLAME PROPAGATION HEIGHT OF ELECTRICAL AND OPTICAL-FIBER CABLES INSTALLED VERTICALLY IN SHAFTS.

UL 910 - TEST FOR FLAME PROPAGATION AND SMOKE DENSITY VALUES FOR AND OPTICAL FIBER CABLES USED IN SPACES ENVIRONMENTAL AIR.

UL 1685 - VERTICAL TRAY FIRE PROPAGATION AND SMOKE RELEASE TEST FOR AND OPTICAL FIBER CABLES.

NEMA WC-5: THERMOPLASTIC-INSULATED WIRE AND CABLE FOR THE TRANSMISSION AND DISTRIBUTION OF ELECTRICAL ENERGY.

FEDERAL SPECIFICATIONS

J-C-30B (1) CABLE AND WIRE, ELECTRICAL (POWER, FIXED INSTALLATION).

COORDINATION

SET SLEEVES IN CAST-IN-PLACE CONCRETE, MASONRY WALLS, AND OTHER STRUCTURAL COMPONENTS AS THEY ARE CONSTRUCTED.

PART 2 PRODUCTS

44.01 CONDUCTORS AND CABLES

MANUFACTURERS, 600 VOLT OR LESS WIRE AND CABLE: SUBJECT TO COMPLIANCE WITH REQUIREMENTS, PROVIDE PRODUCTS BY ONE OF THE FOLLOWING:

CAROL

SOUTH WIRE.

TRIANGLE PCW

AMERICAN INSULATED WIRE CORP

BFCC BRAND

SENATOR WIRE AND CABLE

ENCORE WIRE CORPORATION

COPPER CONDUCTORS: COMPLY WITH NEMA WC 70.

CONDUCTOR INSULATION: COMPLY WITH NEMA WC 70 FOR TYPES THW, THHN-THWN, XHHW, UF, USE AND SO. ALL CONDUCTORS ARE TO BE COPPER WIRE OR CABLE INSULATED FOR 600 V, COLOR CODED FOR THE ENTIRE LENGTH. USE OF ELECTRICAL TAPE FOR MARKING IS STRICTLY PROHIBITED.

CONDUCTORS SHALL BE PROVIDED WITH INSULATION TYPES INDICATED EXPLICITLY ON DRAWINGS, AND SUBSTITUTION IS NOT ACCEPTABLE WITHOUT ENGINEER'S APPROVAL.

WIRING BX AND MC WILL NOT BE ACCEPTABLE FOR USE ON THIS PROJECT. MC MAY BE USED FOR LIGHT FIXTURE WHIPS ONLY.

WHERE INSULATION TYPE IS NOT EXPLICITLY IDENTIFIED ON DRAWINGS, BRANCH CIRCUIT AND FEEDER CIRCUIT CONDUCTORS SHALL HAVE THHN-THWN DUAL-RATED INSULATION.

MULTI-CONDUCTOR CABLE: COMPLY WITH NEMA WC 70 FOR ARMED CABLE, TYPE AC, METAL CLAD CABLE, TYPE MC, MINERAL-INSULATED, SHEATHED CABLE, TYPE MI WITH GROUND WIRE.

CONNECTORS AND SPLICES

AVAILABLE MANUFACTURERS: SUBJECT TO COMPLIANCE WITH REQUIREMENTS, MANUFACTURERS OFFERING PRODUCTS THAT MAY BE INCORPORATED INTO THE WORK INCLUDE, BUT ARE NOT LIMITED TO, THE FOLLOWING:

MANUFACTURERS: SUBJECT TO COMPLIANCE WITH REQUIREMENTS, PROVIDE PRODUCTS BY ONE OF THE FOLLOWING:

AFC CABLE SYSTEMS, INC.

HUBBELL POWER SYSTEMS, INC.

O-Z/GEDNEY; EGS ELECTRICAL GROUP LLC.

3M; ELECTRICAL PRODUCTS DIVISION.

TYCO ELECTRONICS CORP.

DESCRIPTION: FACTORY-FABRICATED CONNECTORS AND SPLICES OF SIZE, AMPACITY RATING, MATERIAL, TYPE, AND CLASS FOR APPLICATION AND SERVICE INDICATED.

SLEEVES FOR CABLES

STEEL PIPE SLEEVES: ASTM A53/A53M, TYPE E, GRADE B, SCHEDULE 40, GALVANIZED STEEL, PLAIN ENDS.

CAST-IRON PIPE SLEEVES: CAST OR FABRICATED "WALL PIPE," EQUIVALENT TO DUCTILE-IRON PRESSURE PIPE, WITH PLAIN ENDS AND INTEGRAL WATER STOP, UNLESS OTHERWISE INDICATED.

SLEEVES FOR RECTANGULAR OPENINGS: GALVANIZED SHEET STEEL WITH MINIMUM 0.052-OR 0.138-INCH THICKNESS AS INDICATED AND OF LENGTH TO SUIT APPLICATION.

COORDINATE SLEEVE SELECTION AND APPLICATION WITH SELECTION AND APPLICATION OF FIRESTOPPING SPECIFIED IN DIVISION 07 SECTION "PENETRATION FIRESTOPPING."

SLEEVE SEALS

MANUFACTURERS: SUBJECT TO COMPLIANCE WITH REQUIREMENTS, PROVIDE PRODUCTS BY ONE OF THE FOLLOWING:

BASIS-OF-DESIGN PRODUCT: SUBJECT TO COMPLIANCE WITH REQUIREMENTS, PROVIDE A COMPARABLE PRODUCT BY ONE OF THE FOLLOWING:

ADVANCE PRODUCTS & SYSTEMS, INC.

CALPICO, INC.

METRAFLEX CO.

PIPELINE SEAL AND INSULATOR, INC.

DESCRIPTION: MODULAR SEALING DEVICE, DESIGNED FOR FIELD ASSEMBLY, TO FILL ANNULAR SPACE BETWEEN SLEEVE AND CABLE.

PART 3 EXECUTION

81.01 CONDUCTOR MATERIAL APPLICATIONS

COPPER:

SOLID FOR #10 AWG AND SMALLER;
STRANDED FOR #8 AWG AND LARGER.

ALUMINUM:

USE ONLY FOR DISTRIBUTION OR SERVICE FEEDERS WHERE EXPLICITLY INDICATED ON DRAWINGS.

USE AA-8030 ALLOY ONLY.

STRANDED ONLY

MINIMUM SIZE: 250 MCM.

PROVIDE COMPRESSION LUGS.

CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

SERVICE ENTRANCE: TYPE XHHW-2 SINGLE CONDUCTORS IN RACEWAY, UNLESS SPECIFICALLY NOTED OTHERWISE ON DRAWINGS.

FEEDERS TO SWITCH BOARDS, DISTRIBUTION-CLASS PANELS, AND MOTOR CONTROL CENTERS LOCATED IN CENTRAL PLANT OR MAIN ELECTRICAL ROOM: TYPE XHHW-2 SINGLE CONDUCTORS IN RACEWAY, UNLESS SPECIFICALLY NOTED OTHERWISE ON DRAWINGS.

FEEDERS TO DISTRIBUTION-CLASS PANELS, LIGHTING-CLASS PANELS, AND DISTRIBUTION EQUIPMENT LOCATED IN ANY OTHER AREA: TYPE THHN/THWN-2 DUAL-RATED INSULATION CONDUCTORS IN RACEWAY, UNLESS SPECIFICALLY NOTED OTHERWISE ON DRAWINGS.

FEEDERS TO EMERGENCY EQUIPMENT: TYPE RHW-2, UNLESS SPECIFICALLY NOTED OTHERWISE ON DRAWINGS.

BRANCH CIRCUITS: TYPE THHN/THWN-2 DUAL-RATED INSULATION CONDUCTORS IN RACEWAY, UNLESS SPECIFICALLY NOTED OTHERWISE ON DRAWINGS.

LIGHTING FIXTURE TAILS: A MAXIMUM OF 6'-0" LENGTH OF MULTI-CONDUCTOR CABLE MAY BE USED FOR LIGHTING FIXTURE CONNECTION FROM ABOVE-CEILING JUNCTION BOXES WITH CODE-REQUIRED SUPPORT AND MINIMUM OF ONE SUPPORT POINT BETWEEN JUNCTION BOX AND FIXTURE.

WIRING DEVICES: MULTI-CONDUCTOR CABLE IS NOT ACCEPTABLE FOR USE IN CONNECTION OF WIRING DEVICES AND ASSOCIATED BOXES.

EQUIPMENT: MULTI-CONDUCTOR CABLE IS NOT ACCEPTABLE FOR USE IN CONNECTION OF EQUIPMENT BY ANY DIVISION.

CONTROL CIRCUITS: TYPE THHN/THWN-2 INCH (50.8 MM) RACEWAY.

INSTALLATION OF CONDUCTORS AND CABLES

CONCEAL CABLES IN FINISHED WALLS, CEILINGS, AND FLOORS, UNLESS OTHERWISE INDICATED.

USE MANUFACTURER-APPROVED PULLING COMPOUND OR LUBRICANT WHERE NECESSARY; COMPOUND USED MUST NOT DETERIORATE CONDUCTOR OR INSULATION. DO NOT EXCEED MANUFACTURER'S RECOMMENDED MAXIMUM PULLING TENSIONS AND SIDEWALL PRESSURE VALUES.

USE PULLING MEANS, INCLUDING FISH TAPE, CABLE, ROPE, AND BASKET-WEAVE WIRE/CABLE GRIPS, THAT WILL NOT DAMAGE CABLES OR RACEWAY. DO NOT RE-PULL WIRES/CONDUCTORS THAT BEEN USED. DO NOT USE ROPE HITCHES FOR PULLING ATTACHMENT TO WIRE OR CABLE.

INSTALL EXPOSED CABLES PARALLEL AND PERPENDICULAR TO SURFACES OF EXPOSED STRUCTURAL MEMBERS AND FOLLOW SURFACE CONTOURS WHERE POSSIBLE.

SUPPORT CABLES ACCORDING TO DIVISION 26 SECTION "HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS."

IDENTIFY AND COLOR-CODE CONDUCTORS AND CABLES ACCORDING TO DIVISION 26 SECTION "IDENTIFICATION FOR ELECTRICAL SYSTEMS."

ALL WIRE SHALL BE INSTALLED IN CONDUIT OR RACEWAYS.

ALL CIRCUITS SHALL HAVE A HOT, NEUTRAL AND GREEN GROUND WIRE UNLESS OTHERWISE INDICATED.

PROVIDE #12 CONDUCTORS AND #12 GROUNDS MINIMUM TO ALL 20 AMP DEVICES UNLESS OTHERWISE INDICATED.

PROVIDE #10 CONDUCTORS AND #10 GROUNDS MINIMUM TO ALL 30 AMP DEVICES UNLESS OTHERWISE INDICATED.

PROVIDE #10 MINIMUM CONDUCTORS FOR 120/208V 20 AMP CIRCUITS FOR WHICH THE DISTANCE FROM THE PANELBOARD TO THE FIRST DEVICE IS GREATER THAN 100 FEET (3048 CM).

PROVIDE #10 MINIMUM CONDUCTORS FOR 277/480V 20 AMP CIRCUITS FOR WHICH THE DISTANCE FROM THE PANELBOARD TO THE FIRST DEVICE IS GREATER THAN 200 FEET (6096 CM) AND FOR ALL GENERAL LIGHTING CIRCUITS WITH CONTINUOUS LOAD GREATER-THAN-OR-EQUAL-TO 3.0 KVA.

DO NOT INSTALL WIRES IN CONDUIT UNTIL ENTIRE SYSTEM OF CONDUIT AND OUTLET BOXES IS PERMANENTLY IN PLACE.

EXERCISE CARE WHEN INSTALLING WIRE IN CONDUIT SO AS TO PREVENT INJURY TO THE CONDUCTOR INSULATION. MECHANICAL MEANS OF PULLING SHALL NOT BE USED UNLESS APPROVED. CONDUCTORS SHALL BE PULLED USING UL NON-FLAMMABLE LISTED LUBRICANT WHEN NECESSARY. DO NOT RE-PULL WIRES/CONDUCTORS THAT BEEN USED.

WHENEVER WIRING LEAVES THE CONDUIT AND TERMINATES AT A TERMINAL BOARD, THE WIRING SHALL BE FORMED AND LACED WITH PLASTIC WIRE TIES. CONDUCTORS ARE TO BE INSTALLED NEAT, ORDER AND WORKMANLIKE MANNER AND ALSO COMPLY PER NEC 70; ARTICLE 312.

IN THE EVENT CIRCUITS FEED THROUGH OUTLET BOXES, PROVIDE SPLICE AND PIGTAIL FOR DEVICE CONNECTION, WITH SUFFICIENT SLACK TO PULL SPLICE OUT OF BOX AT LEAST 6 INCHES (152.4 MM). TERMINATE THE CONDUCTORS AROUND THE TERMINAL SCREWS NOT AT THE BACK OF THE RECEPTACLE.

COORDINATE CABLE INSTALLATION WITH OTHER WORK.

PULL CONDUCTORS SIMULTANEOUSLY WHERE MORE THAN ONE IS BEING INSTALLED IN SAME RACEWAY.

SPLICES:

BRANCH CIRCUITS: KEEP CONDUCTOR SPLICES TO A MINIMUM.

MOTOR BRANCH CIRCUITS: SPLICES ARE NOT ALLOWED IN MOTOR BRANCH CIRCUIT FEEDERS.

RELOCATION OF EXISTING LIGHTING-CLASS PANELS: PROVIDE SPLICES TO EXISTING BRANCH CIRCUITS THAT ARE ACTIVE AND WILL REMAIN IN ABOVE-CEILING JUNCTION BOXES SIZED APPROPRIATELY FOR THE QUANTITY OF CONDUCTORS. VERIFY EXISTING BRANCH CIRCUIT FEEDER CONDITION AND AMPACITY AND PROVIDE NEW FEEDERS WHERE EXISTING VIOLATIONS EXIST. MATCH AND EXTEND BRANCH CIRCUIT FEEDERS FROM SPLICE TO NEW PANEL LOCATION AND PROVIDE NEW BRANCH CIRCUIT BREAKER AS INDICATED IN PANEL SCHEDULES TO RE-FEED EXISTING LOAD.

SERVICE ENTRANCE FEEDERS: SPLICES ARE NOT ALLOWED IN ANY SERVICE ENTRANCE FEEDER(S). ALL CONDUCTORS MUST BE SINGLE LENGTH.

DISTRIBUTION FEEDERS: SPLICES ARE NOT ALLOWED IN ANY DISTRIBUTION FEEDER(S) INCLUDING, BUT NOT LIMITED TO FEEDERS BETWEEN SWITCH BOARDS, DISTRIBUTION-CLASS PANELS, LIGHTING-CLASS PANELS, MOTOR CONTROL CENTERS, TRANSFORMERS, SAFETY SWITCHES, AND MOTOR CONTROLLERS AND DRIVES.

INSTALL SPLICE AND TAP CONNECTORS WHICH POSSESS EQUIVALENT OR BETTER MECHANICAL STRENGTH AND INSULATION RATING THAN CONDUCTORS BEING SPLICED.

USE SPLICE AND TAP CONNECTORS WHICH ARE COMPATIBLE WITH CONDUCTOR MATERIAL.

PROVIDE ADEQUATE LENGTH OF CONDUCTORS WITHIN ELECTRICAL ENCLOSURES AND TRAIN THE CONDUCTORS TO TERMINAL POINTS WITH NO EXCESS. BUNDLE MULTIPLE CONDUCTORS, WITH CONDUCTORS LARGER THAN NO.10 AWG CABLED IN INDIVIDUAL CIRCUITS. MAKE TERMINATIONS SO THERE IS NO BARE CONDUCTOR AT THE TERMINAL.

HOME RUNS: EXCEPT WHERE SPECIFICALLY INDICATED, PROVIDE LIGHTING BRANCH CIRCUIT HOME RUNS WITH NOT MORE THAN THREE DIFFERENT LINE CONDUCTORS AND A COMMON NEUTRAL IN A SINGLE RACEWAY FOR 4-WIRE, 3-PHASE SYSTEMS.

CONDUCTORS MAY BE RUN IN PARALLEL IN SIZES 1/0 THROUGH 750 MCM WHERE INDICATED AND PROVIDED THAT ALL CONDUCTORS OF EACH PHASE ARE THE SAME LENGTH AND SO ARRANGED AND TERMINATED AS TO ENSURE EQUAL DIVISION OF THE CURRENT BETWEEN ALL PARALLELED PHASE CONDUCTORS.

FEEDERS SHALL BE INSTALLED IN CONTINUOUS PIECES WITHOUT SPLICE.

INSTALL A SEPARATE NEUTRAL FOR EACH CIRCUIT WHICH SERVES GFCI OR ISOLATED GROUND RECEPTACLES.

EACH CIRCUIT ORIGINATING FROM A GFCI TYPE CIRCUIT BREAKER SHALL ALSO HAVE A SEPARATE NEUTRAL.

WHERE SPECIFICALLY INDICATED, FOR RECEPTACLE BRANCH CIRCUITS, PROVIDE A SEPARATE NEUTRAL CONDUCTOR FOR EACH LINE CONDUCTOR.

EACH CIRCUIT SERVING RECEPTACLES WHERE DATA TERMINALS ARE USED SHALL HAVE SEPARATE NEUTRAL.

CONNECTIONS

TIGHTEN ELECTRICAL CONNECTORS AND TERMINALS ACCORDING TO MANUFACTURER'S PUBLISHED TORQUE-TIGHTENING VALUES. IF MANUFACTURER'S TORQUE VALUES ARE NOT INDICATED, USE THOSE SPECIFIED IN UL 486A AND UL 486B. PROVIDE DOCUMENTATION AND RECORDS ALL TORQUE TERMINATIONS.

WIRING AT OUTLETS: INSTALL CONDUCTOR AT EACH OUTLET, WITH AT LEAST 6 INCHES (152.4 MM) OF SLACK PER SECTION 300.14.

SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

COORDINATE SLEEVE SELECTION AND APPLICATION WITH SELECTION AND APPLICATION OF FIRESTOPPING SPECIFIED IN DIVISION 07 SECTION "PENETRATION FIRESTOPPING."

CONCRETE SLABS AND WALLS: INSTALL SLEEVES FOR PENETRATIONS UNLESS CORE-DRILLED HOLES OR FORMED OPENINGS ARE USED. INSTALL SLEEVES DURING ERECTION OF SLABS AND WALLS.

USE PIPE SLEEVES UNLESS PENETRATION ARRANGEMENT REQUIRES RECTANGULAR SLEEVED OPENING.

RECTANGULAR SLEEVE MINIMUM METAL THICKNESS:

FOR SLEEVE RECTANGLE PERIMETER LESS THAN 50 INCHES (1270 MM) AND NO SIDE GREATER THAN 16 INCHES (406.4 MM), THICKNESS SHALL BE 0.052 INCH (1.32 MM).

FOR SLEEVE RECTANGLE PERIMETER EQUAL TO, OR GREATER THAN, 50 INCHES (1270 MM) AND 1 OR MORE SIDES EQUAL TO, OR GREATER THAN, 16 INCHES (406.4 MM), THICKNESS SHALL BE 0.138 INCH (3.51 MM).

FIRE-RATED ASSEMBLIES: INSTALL SLEEVES FOR PENETRATIONS OF FIRE-RATED FLOOR AND WALL ASSEMBLIES UNLESS OPENINGS COMPATIBLE WITH FIRESTOP SYSTEM USED ARE FABRICATED DURING CONSTRUCTION OF FLOOR OR WALL.

CUT SLEEVES TO LENGTH FOR MOUNTING FLUSH WITH BOTH WALL SURFACES.

EXTEND SLEEVES INSTALLED IN FLOORS 2 INCHES (50.8 MM) ABOVE FINISHED FLOOR LEVEL.

SIZE PIPE SLEEVES TO PROVIDE 1/4-INCH ANNULAR CLEAR SPACE BETWEEN SLEEVE AND CABLE UNLESS SLEEVE SEAL IS TO BE INSTALLED.

SEAL SPACE OUTSIDE OF SLEEVES WITH GROUT FOR PENETRATIONS OF CONCRETE AND MASONRY AND WITH APPROVED JOINT COMPOUND FOR GYPSUM BOARD ASSEMBLIES.

INTERIOR PENETRATIONS OF NON-FIRE-RATED WALLS AND FLOORS: SEAL ANNULAR SPACE BETWEEN SLEEVE AND CABLE, USING JOINT SEALANT APPROPRIATE FOR SIZE, DEPTH, AND LOCATION OF JOINT ACCORDING TO DIVISION 07 SECTION "JOINT SEALANTS."

FIRE-RATED-ASSEMBLY PENETRATIONS: MAINTAIN INDICATED FIRE RATING OF WALLS, PARTITIONS, CEILINGS, AND FLOORS AT CABLE PENETRATIONS. INSTALL SLEEVES AND SEAL WITH FIRESTOP MATERIALS ACCORDING TO DIVISION 07 SECTION "PENETRATION FIRESTOPPING."

ROOF-PENETRATION SLEEVES: SEAL PENETRATION OF INDIVIDUAL CABLES WITH FLEXIBLE BOOT-TYPE FLASHING UNITS APPLIED IN COORDINATION WITH ROOFING WORK.

ABOVEGROUND EXTERIOR-WALL PENETRATIONS: SEAL PENETRATIONS USING SLEEVES AND MECHANICAL SLEEVE SEALS. SIZE SLEEVES TO ALLOW FOR 1-INCH ANNULAR CLEAR SPACE BETWEEN PIPE AND SLEEVE FOR INSTALLING MECHANICAL SLEEVE SEALS.

UNDERGROUND EXTERIOR-WALL PENETRATIONS: INSTALL CAST-IRON "WALL PIPES" FOR SLEEVES. SIZE SLEEVES TO ALLOW FOR 1-INCH ANNULAR CLEAR SPACE BETWEEN CABLE AND SLEEVE FOR INSTALLING MECHANICAL SLEEVE SEALS.

SLEEVE-SEAL INSTALLATION

INSTALL TO SEAL UNDERGROUND EXTERIOR-WALL PENETRATIONS.

USE TYPE AND NUMBER OF SEALING ELEMENTS RECOMMENDED BY MANUFACTURER FOR CABLE MATERIAL AND SIZE. POSITION CABLE IN CENTER OF SLEEVE. ASSEMBLE MECHANICAL SLEEVE SEALS AND INSTALL IN ANNULAR SPACE BETWEEN CABLE AND SLEEVE. TIGHTEN BOLTS AGAINST PRESSURE PLATES THAT CAUSE SEALING ELEMENTS TO EXPAND AND MAKE WATERTIGHT SEAL.

FIRESTOPPING

APPLY FIRESTOPPING TO ELECTRICAL PENETRATIONS OF FIRE-RATED FLOOR AND WALL ASSEMBLIES TO RESTORE ORIGINAL FIRE-RESISTANCE RATING OF ASSEMBLY ACCORDING TO DIVISION 07 SECTION "PENETRATION FIRESTOPPING."

FIELD QUALITY CONTROL

PERFORM TESTS AND INSPECTIONS AND PREPARE TEST REPORTS.

TESTS AND INSPECTIONS:

AFTER INSTALLING CONDUCTORS AND CABLES AND BEFORE ELECTRICAL CIRCUITRY HAS BEEN ENERGIZED, TEST SERVICE ENTRANCE AND FEEDER CONDUCTORS, AND CONDUCTORS FEEDING THE FOLLOWING CRITICAL EQUIPMENT AND SERVICES FOR COMPLIANCE WITH REQUIREMENTS.

PERFORM EACH VISUAL AND MECHANICAL INSPECTION AND ELECTRICAL TEST STATED IN NETA ACCEPTANCE TESTING SPECIFICATION. CERTIFY COMPLIANCE WITH TEST PARAMETERS.

PERFORM INSULATION RESISTANCE TEST FOR ALL BRANCH AND MAIN CIRCUIT CONDUCTOR. PERFORM TEST ON EACH CONDUCTOR WITH RESPECT TO GROUND AND ADJACENT CONDUCTOR. APPLIED POTENTIAL SHALL BE 1000 VOLTS DC FOR ONE MINUTE. TEST VALUES SHALL BE EVALUATED AND CONDUCTORS WITH VALUES LESS THAN 50 MEGOHMS SHALL BE INVESTIGATED. REPLACE ANY CABLE READING LESS THAN 1 MEGOHM.

PROVIDE TORQUE TEST FOR ALL CONDUCTOR TERMINATIONS IN TRANSFORMERS, SWITCHBOARDS; DISCONNECT SWITCHES, PANELBOARDS, ETC IN ACCORDANCE WITH NETA STANDARDS. RECORD TEST RESULT IN ACCORDANCE WITH ITEM D BELOW.

INFRARED SCANNING: AFTER SUBSTANTIAL COMPLETION, BUT NOT MORE THAN 60 DAYS AFTER FINAL ACCEPTANCE, PERFORM AN INFRARED SCAN OF EACH TERMINATION OF CABLES AND CONDUCTORS NO. 3 AWG AND LARGER. REMOVE BOX AND EQUIPMENT COVERS SO TERMINATIONS ARE ACCESSIBLE TO PORTABLE SCANNER.

- A. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
- B. Record of Infrared Scanning: Prepare a certified report that identifies terminations checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

TEST REPORTS: PREPARE A WRITTEN REPORT TO RECORD THE FOLLOWING:

TEST PROCEDURES USED.

TEST RESULTS THAT COMPLY WITH REQUIREMENTS.

TEST RESULTS THAT DO NOT COMPLY WITH REQUIREMENTS AND CORRECTIVE ACTION TAKEN TO ACHIEVE COMPLIANCE WITH REQUIREMENTS.

REMOVE AND REPLACE MALFUNCTIONING UNITS AND RETEST AS SPECIFIED ABOVE.

CLEANING:

CLEAN THE AREA AROUND AND ON TOP OF THE EQUIPMENT.

END OF SECTION

26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

3.01 REFERENCE STANDARDS

- A. 29 CFR 1910 - Occupational Safety and Health Standards; Current Edition.
- B. ASTM B3 - Standard Specification for Soft or Annealed Copper Wire; 2013 (Reapproved 2024).
- C. ASTM B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft; 2023.
- D. ASTM B33 - Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes; 2010, with Editorial Revision (2020).
- E. IEEE 81 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System; 2025.
- F. IEEE C2 - National Electrical Safety Code(R) (NESC(R)); 2023.
- G. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- H. NFPA 70B - Recommended Practice for Electrical Equipment Maintenance; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- I. NFPA 780 - Standard for the Installation of Lightning Protection Systems; 2026.
- J. UL 96 - Lightning Protection Components; Current Edition, Including All Revisions.
- K. UL 467 - Grounding and Bonding Equipment; Current Edition, Including All Revisions.

3.02 RELATED DOCUMENTS

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

3.03 SUMMARY

- A. This Section includes methods and materials for grounding systems and equipment, plus the following special applications:
 - 1. Underground distribution grounding.
 - 2. Common ground bonding with lightning protection system.

3.04 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Retain paragraph and subparagraphs below to require that Contractor provide drawings to locate significant grounding features. Division 01 Sections "Project Record Documents" and "Operation and Maintenance Data" require submittals to be included in those documents for use by maintenance forces throughout the life of the Project.
- C. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features specified in Part 3 "Field Quality Control" Article, including the following:
 - 1. Test wells.
 - 2. Ground rods.
 - 3. Ground rings.
 - 4. Grounding arrangements and connections for separately derived systems.
 - 5. Grounding for sensitive electronic equipment.
- D. Qualification Data: For testing agency and testing agency's field supervisor.

- E. Field quality-control test reports.
- F. Operation and Maintenance Data: For grounding to include the following in emergency, operation, and maintenance manuals:
 - 1. Instructions for periodic testing and inspection of grounding features at ground rings grounding connections for separately derived systems based on NFPA 70B.
 - a. Tests shall be to determine if ground resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if they do not.
 - b. Include recommended testing intervals.
 - c. Records documentation is required for all testing.

3.05 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience, certified and capability to conduct the testing indicated, that is a member company of the International Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the International Electrical Testing Association to supervise on-site testing specified in Part 3.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 PRODUCTS

4.01 GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

- A. Acceptable Manufacturers: Erico, Copper weld, Cad weld, Bundy

4.02 CONDUCTORS

- A. Insulated Conductors: All conductors are to be Copper wire or cable insulated for 600 V,color coded for the entire length. Use of electrical tape for marking is strictly prohibited.
- B. Bare Copper Conductors: Only where specifically indicated on Drawings.
 - 1. Solid Conductors: ASTM B3.
 - 2. Stranded Conductors: ASTM B8.
 - 3. Tinned Conductors: ASTM B33.
 - 4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor and 1/4 inch (6.35 mm) in diameter.
 - 5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
 - 6. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.59 mm) thick.
 - 7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.59 mm) thick.
- C. Bare Grounding Conductor and Conductor Protector for Wood Poles:
 - 1. No. 4 AWG minimum, soft-drawn copper.
 - 2. Conductor Protector: Half-round PVC or wood molding. If wood, use pressure-treated fir or cypress or cedar.
- D. Grounding Bus: Rectangular bars of annealed copper, 1/4 by 2 inches (50.8 mm) in cross section, unless otherwise indicated; with insulators.

4.03 CONNECTORS

- A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.
 - 1. Pipe Connectors: Clamp type, sized for pipe.
- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

4.04 GROUNDING ELECTRODES

- A. Ground Rods: Copper-bonded steel; 3/4 inch diameter by 10 feet length; minimum 13 mil (0.3302 mm) plating thickness.

PART 3 EXECUTION

5.01 APPLICATIONS

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger, unless otherwise indicated.
- B. Underground Grounding Conductors: Install bare tinned copper conductor, No. 2/0 AWG minimum.
 - 1. Bury at least 24 inches (609.6 mm) below grade.
 - 2. Duct-Bank Grounding Conductor: Bury 12 inches (304.8 mm) above duct bank when indicated as part of duct-bank installation.
- C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.
- D. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
 - 1. Install bus on insulated spacers 1 inch (25.4 mm), minimum, from wall 6 inches (152.4 mm) above finished floor, unless otherwise indicated.
 - 2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, down to specified height above floor, and connect to horizontal bus.
 - 3. Install grounding conductor from main service to the grounding bus. The minimum conductor used per Article 250.
- E. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
 - 3. Connections to Ground Rods at Test Wells: Bolted connectors.
 - 4. Connections to Structural Steel: Welded connectors.

5.02 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. Comply with IEEE C2 grounding requirements.
- B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches (101.6 mm) will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches (50.8 mm) above to 6 inches (152.4 mm) below concrete. Seal floor opening with waterproof, non-shrink grout.

- C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.
- D. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches (152.4 mm) from the foundation.

5.03 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
 - 1. Feeders and branch circuits.
 - 2. Lighting circuits.
 - 3. Receptacle circuits.
 - 4. Single-phase motor and appliance branch circuits.
 - 5. Three-phase motor and appliance branch circuits.
 - 6. Flexible raceway runs.
 - 7. Armored and metal-clad cable runs.
 - 8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
 - 9. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.
- C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- D. Water Heater, Heat-Tracing, and Anti-frost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
- E. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.
- F. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.
- G. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.

1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-2-by-12-inch grounding bus.
 2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.
- H. Metal Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

5.04 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Common Ground Bonding with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor and install in conduit.
- C. Ground Rods: Drive rods until tops are 2 inches (50.8 mm) below finished floor or final grade, unless otherwise indicated.
1. Use same-manufacturer, matched driving tool to drive ground rods without deformation. "Mushroomed" or otherwise deformed rods will be field-rejected.
 2. Replace grounding rods that are deformed at no cost to Owner.
 3. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated.
 4. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.
- D. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Division 26 Section "Underground Ducts and Raceways for Electrical Systems," and shall be at least 12 inches (304.8 mm) deep, with cover.
1. Test Wells: Install at least one test well for each service, unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.
- E. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.
1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
 3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.
- F. Grounding and Bonding for Piping:
1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
 2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.

3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- G. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.
- H. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet (1828.8 cm) apart.
- I. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each indicated item, extending around the perimeter of building.
 1. Install tinned-copper conductor not less than No. 2/0 AWG for ground ring and for taps to building steel.
 2. Bury ground ring not less than 24 inches (609.6 mm) from building foundation.

5.05 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:
- B. Perform the following tests and inspections and prepare test reports:
 1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
 2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal and at individual ground rods. Make tests at ground rods before any conductors are connected.
 - a. Measure ground resistance not less 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.
 3. Prepare dimensioned drawings locating each test well, ground rod and ground rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
- C. Report measured ground resistances that exceed the following values:
 1. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 1 Ω .
 2. Power Distribution Units or Panelboards Serving Electronic Equipment: 0.5 Ω .
 3. Substations and Pad-Mounted Equipment: 0.5 Ω .
 4. Manhole Grounds: 5 Ω .
- D. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Engineer promptly and include recommendations to reduce ground resistance.

END OF SECTION

26 05 29

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

3.01 REFERENCE STANDARDS

- A. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.
- B. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2025, with Amendment (2026).
- C. MFMA-4 - Metal Framing Standards Publication; 2004.
- D. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2025.
- E. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.
- F. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT); 2020.
- G. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- H. SSPC-PA 1 - Shop, Field, and Maintenance Coating of Metals; 2024, with Errata (2025).

3.02 RELATED DOCUMENTS

DRAWINGS AND GENERAL PROVISIONS OF THE CONTRACT, INCLUDING GENERAL AND SUPPLEMENTARY CONDITIONS AND DIVISION 01 SPECIFICATION SECTIONS, APPLY TO THIS SECTION.

SUMMARY

- A. This Section includes the following:

HANGERS AND SUPPORTS FOR ELECTRICAL EQUIPMENT AND SYSTEMS.

CONSTRUCTION REQUIREMENTS FOR CONCRETE BASES.

DEFINITIONS

- A. Retain abbreviations that remain after this Section has been edited.
- B. EMT: Electrical metallic tubing.
- C. IMC: Intermediate metal conduit.
- D. RMC: Rigid metal conduit.

PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

SUBMITTALS

- A. Product Data: For the following:

STEEL SLOTTED SUPPORT SYSTEMS.

NONMETALLIC SLOTTED SUPPORT SYSTEMS.

- A. Shop Drawings: Show fabrication and installation details and include calculations for the following:

TRAPEZE HANGERS. INCLUDE PRODUCT DATA FOR COMPONENTS.

STEEL SLOTTED CHANNEL SYSTEMS. INCLUDE PRODUCT DATA FOR COMPONENTS.

NONMETALLIC SLOTTED CHANNEL SYSTEMS. INCLUDE PRODUCT DATA FOR COMPONENTS.

EQUIPMENT SUPPORTS.

QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Comply with NFPA 70.

COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 PRODUCTS

19.01 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Retain this Article to specify default product requirements for basic supporting devices. Items to be supported include raceways, cables, wireways, cable trays, busways, boxes, cabinets, equipment, and other electrical products. Where support materials or workmanship is unique to a particular product, specify unique features that are the exception to these default requirements in the Section that specifies the product. Coordinate specifications for supporting devices with structural engineer and with Drawings.

STEEL SLOTTED SUPPORT SYSTEMS: COMPLY WITH MFMA-4, FACTORY-FABRICATED COMPONENTS FOR FIELD ASSEMBLY.

AVAILABLE MANUFACTURERS: SUBJECT TO COMPLIANCE WITH REQUIREMENTS, MANUFACTURERS OFFERING PRODUCTS THAT MAY BE INCORPORATED INTO THE WORK INCLUDE, BUT ARE NOT LIMITED TO, THE FOLLOWING:

1. Allied Tube & Conduit.
2. Cooper B-Line, Inc.; a division of Cooper Industries.
3. ERICO International Corporation.
4. Thomas & Betts Corporation.
5. Unistrut; Tyco International, Ltd.

METALLIC COATINGS: HOT-DIP GALVANIZED AFTER FABRICATION AND APPLIED ACCORDING TO MFMA-4.

NONMETALLIC COATINGS: MANUFACTURER'S STANDARD PVC, POLYURETHANE, OR POLYESTER COATING APPLIED ACCORDING TO MFMA-4.

PAINTED COATINGS: MANUFACTURER'S STANDARD PAINTED COATING APPLIED ACCORDING TO MFMA

CHANNEL DIMENSIONS: SELECTED FOR APPLICABLE LOAD CRITERIA.

NONMETALLIC SLOTTED SUPPORT SYSTEMS: STRUCTURAL-GRADE, FACTORY-FORMED, GLASS-FIBER-RESIN CHANNELS AND ANGLES WITH 9/16-INCH DIAMETER HOLES AT A MAXIMUM OF 8 INCHES (203.2 MM) O.C., IN AT LEAST 1 SURFACE.

AVAILABLE MANUFACTURERS: SUBJECT TO COMPLIANCE WITH REQUIREMENTS, MANUFACTURERS OFFERING PRODUCTS THAT MAY BE INCORPORATED INTO THE WORK INCLUDE, BUT ARE NOT LIMITED TO, THE FOLLOWING:

MANUFACTURERS: SUBJECT TO COMPLIANCE WITH REQUIREMENTS, PROVIDE PRODUCTS BY ONE OF THE FOLLOWING:

1. Allied Tube & Conduit.
2. Cooper B-Line, Inc.; a division of Cooper Industries.
3. Fabco Plastics Wholesale Limited.

FITTINGS AND ACCESSORIES: PRODUCTS OF CHANNEL AND ANGLE MANUFACTURER AND DESIGNED FOR USE WITH THOSE ITEMS.

FITTING AND ACCESSORY MATERIALS: SAME AS CHANNELS AND ANGLES EXCEPT METAL ITEMS MAY BE STAINLESS STEEL.

RATED STRENGTH: SELECTED TO SUIT APPLICABLE LOAD CRITERIA.

RACEWAY AND CABLE SUPPORTS: AS DESCRIBED IN NECA 1 AND NECA 101.

CONDUIT AND CABLE SUPPORT DEVICES: STEEL AND MALLEABLE-IRON HANGERS, CLAMPS, AND ASSOCIATED FITTINGS, DESIGNED FOR TYPES AND SIZES OF RACEWAY OR CABLE TO BE SUPPORTED.

SUPPORT FOR CONDUCTORS IN VERTICAL CONDUIT: FACTORY-FABRICATED ASSEMBLY CONSISTING OF THREADED BODY AND INSULATING WEDGING PLUG OR PLUGS FOR NON-ARMORED ELECTRICAL CONDUCTORS OR CABLES IN RISER CONDUITS. PLUGS SHALL HAVE NUMBER, SIZE, AND SHAPE OF CONDUCTOR GRIPPING PIECES AS REQUIRED TO SUIT INDIVIDUAL CONDUCTORS OR CABLES SUPPORTED. BODY SHALL BE MALLEABLE IRON.

STRUCTURAL STEEL FOR FABRICATED SUPPORTS AND RESTRAINTS: ASTM A36/A36M, STEEL PLATES, SHAPES, AND BARS; BLACK AND GALVANIZED.

MOUNTING, ANCHORING, AND ATTACHMENT COMPONENTS: ITEMS FOR FASTENING ELECTRICAL ITEMS OR THEIR SUPPORTS TO BUILDING SURFACES INCLUDE THE FOLLOWING:

POWDER-ACTUATED FASTENERS: THREADED-STEEL STUD, FOR USE IN HARDENED PORTLAND CEMENT CONCRETE, STEEL, OR WOOD, WITH TENSION, SHEAR, AND PULLOUT CAPACITIES APPROPRIATE FOR SUPPORTED LOADS AND BUILDING MATERIALS WHERE USED.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hilti Inc.
 - b. ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - c. MKT Fastening, LLC.

- d. Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.

MECHANICAL-EXPANSION ANCHORS: INSERT-WEDGE-TYPE, STEEL, FOR USE IN HARDENED PORTLAND CEMENT CONCRETE WITH TENSION, SHEAR, AND PULLOUT CAPACITIES APPROPRIATE FOR SUPPORTED LOADS AND BUILDING MATERIALS IN WHICH USED.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Cooper B-Line, Inc.; a division of Cooper Industries.
 - b. Empire Tool and Manufacturing Co., Inc.
 - c. Hilti Inc.
 - d. ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - e. MKT Fastening, LLC.

CONCRETE INSERTS: STEEL OR MALLEABLE-IRON, SLOTTED SUPPORT SYSTEM UNITS SIMILAR TO MSS TYPE 18; COMPLYING WITH MFMA-4 OR MSS SP-58.

CLAMPS FOR ATTACHMENT TO STEEL STRUCTURAL ELEMENTS: MSS SP-58, TYPE SUITABLE FOR ATTACHED STRUCTURAL ELEMENT.

THROUGH BOLTS: STRUCTURAL TYPE, HEX HEAD, AND HIGH STRENGTH. COMPLY WITH ASTM A 325.

TOGGLE BOLTS: ALL-STEEL SPRINGHEAD TYPE.

HANGER RODS: THREADED STEEL.

FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

PART 3 EXECUTION

45.01 APPLICATION

COMPLY WITH NECA 1 AND NECA 101 FOR APPLICATION OF HANGERS AND SUPPORTS FOR ELECTRICAL EQUIPMENT AND SYSTEMS EXCEPT IF REQUIREMENTS IN THIS SECTION ARE STRICTER.

MAXIMUM SUPPORT SPACING AND MINIMUM HANGER ROD SIZE FOR RACEWAY: SPACE SUPPORTS FOR EMT, IMC, AND RMC AS REQUIRED BY NFPA 70. MINIMUM ROD SIZE SHALL BE 1/4 INCH (6.35 MM) IN DIAMETER.

MULTIPLE RACEWAYS OR CABLES: INSTALL TRAPEZE-TYPE SUPPORTS FABRICATED WITH STEEL SLOTTED OR OTHER SUPPORT SYSTEM, SIZED SO CAPACITY CAN BE INCREASED BY AT LEAST 25 PERCENT IN FUTURE WITHOUT EXCEEDING SPECIFIED DESIGN LOAD LIMITS.

SECURE RACEWAYS AND CABLES TO THESE SUPPORTS WITH TWO-BOLT CONDUIT CLAMPS.

SPRING-STEEL CLAMPS DESIGNED FOR SUPPORTING SINGLE CONDUITS WITHOUT BOLTS MAY BE USED FOR 1-1/2-INCH AND SMALLER RACEWAYS SERVING BRANCH CIRCUITS AND COMMUNICATION SYSTEMS ABOVE SUSPENDED CEILINGS AND FOR FASTENING RACEWAYS TO TRAPEZE SUPPORTS.

ALL CONDUITS SHALL BE INSTALLED IN UNIFORMITY, NEAT AND EQUAL SPACE.

SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

TO WOOD: FASTEN WITH LAG SCREWS OR THROUGH BOLTS.

TO NEW CONCRETE: BOLT TO CONCRETE INSERTS.

TO MASONRY: APPROVED TOGGLE-TYPE BOLTS ON HOLLOW MASONRY UNITS AND EXPANSION ANCHOR FASTENERS ON SOLID MASONRY UNITS.

TO EXISTING CONCRETE: EXPANSION ANCHOR FASTENERS.

INSTEAD OF EXPANSION ANCHORS, POWDER-ACTUATED DRIVEN THREADED STUDS PROVIDED WITH LOCK WASHERS AND NUTS MAY BE USED IN EXISTING STANDARD-WEIGHT CONCRETE 4 INCHES (101.6 MM) THICK OR GREATER. DO NOT USE FOR ANCHORAGE TO LIGHTWEIGHT-AGGREGATE CONCRETE OR FOR SLABS LESS THAN 4 INCHES THICK.

TO STEEL: WELDED THREADED STUDS COMPLYING WITH AWS D1.1/D1.1M, WITH LOCK WASHERS AND NUTS.

TO LIGHT STEEL: SHEET METAL SCREWS.

ITEMS MOUNTED ON HOLLOW WALLS AND NONSTRUCTURAL BUILDING SURFACES: MOUNT CABINETS, PANELBOARDS, DISCONNECT SWITCHES, CONTROL ENCLOSURES, PULL AND JUNCTION BOXES, TRANSFORMERS, AND OTHER DEVICES ON SLOTTED-CHANNEL RACKS ATTACHED TO SUBSTRATE BY MEANS THAT MEET SEISMIC-RESTRAINT STRENGTH AND ANCHORAGE REQUIREMENTS.

- A. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

CONCRETE BASES

- A. Construct concrete bases of dimensions indicated but not less than 4 inches (101.6 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section "Cast-in-Place Concrete."
- C. Anchor equipment to concrete base.

PLACE AND SECURE ANCHORAGE DEVICES. USE SUPPORTED EQUIPMENT MANUFACTURER'S SETTING DRAWINGS, TEMPLATES, DIAGRAMS, INSTRUCTIONS, AND DIRECTIONS FURNISHED WITH ITEMS TO BE EMBEDDED.

INSTALL ANCHOR BOLTS TO ELEVATIONS REQUIRED FOR PROPER ATTACHMENT TO SUPPORTED EQUIPMENT.

INSTALL ANCHOR BOLTS ACCORDING TO ANCHOR-BOLT MANUFACTURER'S WRITTEN INSTRUCTIONS.

PAINTING

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

APPLY PAINT BY BRUSH OR SPRAY TO PROVIDE MINIMUM DRY FILM THICKNESS OF 2.0 MILS (0.0508 MM).

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

END OF SECTION

THIS PAGE LEFT BLANK INTENTIONALLY

RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

2.01 REFERENCE STANDARDS

- A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC); 2025.
- B. ANSI C80.3 - American National Standard for Electrical Metallic Tubing -- Steel (EMT-S); 2020.
- C. ANSI C80.5 - American National Standard for Electrical Rigid Metal Conduit - Aluminum (ERMC-A); 2025.
- D. ANSI C80.6 - American National Standard for Electrical Intermediate Metal Conduit; 2025.
- E. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2024.
- F. ISO 9000 - Quality Management Systems -- Fundamentals and Vocabulary; 2015.
- G. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.
- H. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2014.
- I. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports; 2013 (Reaffirmed 2020).
- J. NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports; 2013 (Reaffirmed 2020).
- K. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit; 2020.
- L. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing; 2021.
- M. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- N. SCTE 77 - Specifications for Underground Enclosure Integrity; 2023.
- O. UL 5 - Surface Metal Raceways and Fittings; Current Edition, Including All Revisions.
- P. UL 514B - Conduit, Tubing, and Cable Fittings; Current Edition, Including All Revisions.
- Q. UL 870 - Wireways, Auxiliary Gutters, and Associated Fittings; Current Edition, Including All Revisions.
- R. UL 1660 - Liquid-Tight Flexible Nonmetallic Conduit; Current Edition, Including All Revisions.
- S. UL 2024 - Standard for Cable Routing Assemblies and Communications Raceways; Current Edition, Including All Revisions.

2.02 RELATED DOCUMENTS

DRAWINGS AND GENERAL PROVISIONS OF THE CONTRACT, INCLUDING GENERAL AND SUPPLEMENTARY CONDITIONS AND DIVISION 01 SPECIFICATION SECTIONS, APPLY TO THIS SECTION.

REQUIREMENTS OF DIVISION 26 "BASIC ELECTRICAL REQUIREMENTS" APPLY TO THIS SECTION

SUMMARY

THIS SECTION INCLUDES RACEWAYS, FITTINGS, BOXES, ENCLOSURES, AND CABINETS FOR ELECTRICAL WIRING.

RELATED SECTIONS INCLUDE THE FOLLOWING:

DIVISION 26 SECTION "UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS" FOR EXTERIOR DUCTBANKS, MANHOLES, AND UNDERGROUND UTILITY CONSTRUCTION.

DEFINITIONS

EMT: ELECTRICAL METALLIC TUBING.

ENT: ELECTRICAL NONMETALLIC TUBING.

EPDM: ETHYLENE-PROPYLENE-DIENETERPOLYMER RUBBER.

FMC: FLEXIBLE METAL CONDUIT.

IMC: INTERMEDIATE METAL CONDUIT.

LFMC: LIQUIDTIGHT FLEXIBLE METAL CONDUIT.

LFNC: LIQUIDTIGHT FLEXIBLE NONMETALLIC CONDUIT.

NBR: ACRYLONITRILE-BUTADIENE RUBBER.

RNC: RIGID NONMETALLIC CONDUIT.

RMC: RIGID METAL CONDUIT.

RGS: RIGID GALVANIZED STEEL CONDUIT.

RAL: RIGID ALUMINUM CONDUIT.

SUBMITTALS

PRODUCT DATA: FOR SURFACE RACEWAYS, WIREWAYS AND FITTINGS, FLOOR BOXES, HINGED-COVER ENCLOSURES, AND CABINETS.

MANUFACTURER'S INSTRUCTIONS: INDICATE APPLICATION CONDITIONS, LIMITATIONS, AND MAXIMUM CONDUCTOR FILL.

SHOP DRAWINGS: FOR THE FOLLOWING RACEWAY COMPONENTS. INCLUDE PLANS, ELEVATIONS, SECTIONS, DETAILS, AND ATTACHMENTS TO OTHER WORK.

CUSTOM ENCLOSURES AND CABINETS.

FOR HANDHOLES AND BOXES FOR UNDERGROUND WIRING, INCLUDING THE FOLLOWING:

- A. Duct entry provisions, including locations and duct sizes.
- B. Frame and cover design.
- C. Grounding details.
- D. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.
- E. Joint details.

COORDINATION DRAWINGS: CONDUIT ROUTING PLANS, DRAWN TO SCALE, ON WHICH THE FOLLOWING ITEMS ARE SHOWN AND COORDINATED WITH EACH OTHER, BASED ON INPUT FROM INSTALLERS OF THE ITEMS INVOLVED:

STRUCTURAL MEMBERS IN THE PATHS OF CONDUIT GROUPS WITH COMMON SUPPORTS.

HVAC AND PLUMBING ITEMS AND ARCHITECTURAL FEATURES IN THE PATHS OF CONDUIT GROUPS WITH COMMON SUPPORTS.

QUALIFICATION DATA: FOR PROFESSIONAL ENGINEER AND TESTING AGENCY.

SOURCE QUALITY-CONTROL TEST REPORTS.

QUALITY ASSURANCE

ELECTRICAL COMPONENTS, DEVICES, AND ACCESSORIES: LISTED AND LABELED AS DEFINED IN NFPA 70, ARTICLE 100, BY A TESTING AGENCY ACCEPTABLE TO AUTHORITIES HAVING JURISDICTION, AND MARKED FOR INTENDED USE.

COMPLY WITH NFPA 70, UL 5 SURFACE METAL ELECTRIC RACEWAYS AND FITTINGS GUIDE RJPR, UL 870 WIRE WAY, AUXILIARY GUTTERS AND ASSOCIATED FITTINGS.

PART 2 PRODUCTS

36.01 METAL CONDUIT AND TUBING

MANUFACTURERS: SUBJECT TO COMPLIANCE WITH REQUIREMENTS, PROVIDE PRODUCTS BY ONE OF THE FOLLOWING: ACCEPTABLE MANUFACTURERS: TRIANGLE, REPUBLIC, CARLEN, CENTEX, WESTERN TUBE APPLETON, CROUSE HINDS, STEEL CITY, OOZY. GENDER, RACE AFC CABLE SYSTEMS, INC.

ALFLEX INC.

ALLIED TUBE & CONDUIT; A TYCO INTERNATIONAL LTD. CO.

ANAMET ELECTRICAL, INC.; ANACONDA METAL HOSE.

ELECTRI-FLEX CO.

MANHATTAN/CDT/COLE-FLEX.

MAVERICK TUBE CORPORATION.

O-Z GEDNEY; A UNIT OF GENERAL SIGNAL.

WHEATLAND TUBE COMPANY.

RIGID STEEL CONDUIT: ANSI C80.1.

RIGID ALUMINUM CONDUIT: ANSI C80.5.

IMC: ANSI C80.6.

PVC-COATED STEEL CONDUIT: PVC-COATED RIGID STEEL CONDUIT.

COMPLY WITH NEMA RN 1.

COATING THICKNESS: 0.040 INCH (1.02 MM), MINIMUM.

EMT: ANSI C80.3.

FMC: FULL WALL, LOW-CARBON STEEL WITH ELECTROGALVANIZED ZINC COATING. REDUCED WALL NOT ACCEPTABLE.

LFMC: FLEXIBLE STEEL CONDUIT WITH PVC JACKET AND UL BONDED STRIP FOR GROUNDING.

FITTINGS FOR CONDUIT (INCLUDING ALL TYPES AND FLEXIBLE AND LIQUIDTIGHT), EMT, AND CABLE: NEMA FB 1; LISTED FOR TYPE AND SIZE RACEWAY WITH WHICH USED, AND FOR APPLICATION AND ENVIRONMENT IN WHICH INSTALLED.

CONDUIT FITTINGS FOR HAZARDOUS (CLASSIFIED) LOCATIONS: COMPLY WITH UL 886.

FITTINGS FOR EMT: COMPRESSION TYPE.

COATING FOR FITTINGS FOR PVC-COATED CONDUIT: MINIMUM THICKNESS, 0.040 INCH (1.02 MM), WITH OVERLAPPING SLEEVES PROTECTING THREADED JOINTS.

MANUFACTURERS: SUBJECT TO COMPLIANCE WITH REQUIREMENTS, PROVIDE PRODUCTS BY ONE OF THE FOLLOWING:

- A. Anamet Electrical, Inc.; Anaconda Metal
- B. Electri-Flex Co.
- C. Triangle PCW, Inc

STEEL SET SCREW FITTINGS FOR ELECTRICAL CONDUIT ARE ALLOWED ONLY FOR EMT LOCATED IN CONDITIONED SPACES.

ALL EXTERIOR RACEWAYS SHALL BE RIGID GALVANIZED STEEL, UNLESS SPECIFICALLY INDICATED OTHERWISE ON DRAWINGS.

JOINT COMPOUND FOR RIGID STEEL CONDUIT OR IMC: LISTED FOR USE IN CABLE CONNECTOR ASSEMBLIES, AND COMPOUNDED FOR USE TO LUBRICATE AND PROTECT THREADED RACEWAY JOINTS FROM CORROSION AND ENHANCE THEIR CONDUCTIVITY.

NONMETALLIC CONDUIT AND TUBING

AVAILABLE MANUFACTURERS: SUBJECT TO COMPLIANCE WITH REQUIREMENTS, MANUFACTURERS OFFERING PRODUCTS THAT MAY BE INCORPORATED INTO THE WORK INCLUDE, BUT ARE NOT LIMITED TO, THE FOLLOWING:

MANUFACTURERS: SUBJECT TO COMPLIANCE WITH REQUIREMENTS, PROVIDE PRODUCTS BY ONE OF THE FOLLOWING:

AFC CABLE SYSTEMS, INC.

ANAMET ELECTRICAL, INC.; ANACONDA METAL HOSE.

ARNCO CORPORATION.

CANTEX INC.

CERTAINTED CORP.; PIPE & PLASTICS GROUP.

CONDUX INTERNATIONAL, INC.

ELECSYS, INC.

ELECTRI-FLEX CO.

LAMSON & SESSIONS; CARLON ELECTRICAL PRODUCTS.

MANHATTAN/CDT/COLE-FLEX.

RACO; A HUBBELL COMPANY.

THOMAS & BETTS CORPORATION.

ENT: NEMA TC 13.

RNC: NEMA TC 2, TYPE EPC-40-PVC, UNLESS OTHERWISE INDICATED ON DRAWINGS.

LFNC: UL 1660.

FITTINGS FOR ENT AND RNC: NEMA TC 3; MATCH TO CONDUIT OR TUBING TYPE AND MATERIAL.

FITTINGS FOR LFNC: UL 514B.

ALL UNDERGROUND RACEWAYS SHALL BE SCHEDULE 40 PVC, UNLESS OTHERWISE INDICATED ON DRAWINGS.

OPTICAL FIBER/COMMUNICATIONS CABLE RACEWAY AND FITTINGS

AVAILABLE MANUFACTURERS: SUBJECT TO COMPLIANCE WITH REQUIREMENTS, MANUFACTURERS OFFERING PRODUCTS THAT MAY BE INCORPORATED INTO THE WORK INCLUDE, BUT ARE NOT LIMITED TO, THE FOLLOWING:

MANUFACTURERS: SUBJECT TO COMPLIANCE WITH REQUIREMENTS, PROVIDE PRODUCTS BY ONE OF THE FOLLOWING:

ARNCO CORPORATION.

ENDOT INDUSTRIES INC.

IPEX INC.

LAMSON & SESSIONS; CARLON ELECTRICAL PRODUCTS.

DESCRIPTION: COMPLY WITH UL 2024; FLEXIBLE TYPE, APPROVED FOR GENERAL-USE INSTALLATION.

METAL WIREWAYS

AVAILABLE MANUFACTURERS: SUBJECT TO COMPLIANCE WITH REQUIREMENTS, MANUFACTURERS OFFERING PRODUCTS THAT MAY BE INCORPORATED INTO THE WORK INCLUDE, BUT ARE NOT LIMITED TO, THE FOLLOWING:

MANUFACTURERS: SUBJECT TO COMPLIANCE WITH REQUIREMENTS, PROVIDE PRODUCTS BY ONE OF THE FOLLOWING:

COOPER B-LINE, INC.

HOFFMAN.

SQUARE D; SCHNEIDER ELECTRIC.

TANCO.

GENERAL ELECTRIC.

WESTINGHOUSE/CUTLER HAMMER.

DESCRIPTION: SHEET METAL SIZED AND SHAPED AS INDICATED, NEMA 250, TYPE 1, 12, 3R, UNLESS OTHERWISE INDICATED. PROVIDE ELECTRICAL WIRE WAYS OF GRADES AND NUMBER OF CHANNELS FOR EACH TYPE OF SERVICE AS INDICATED. COMPLY WITH U.L. 870 "WIRE WAY, AUXILIARY GUTTERS AND ASSOCIATED FITTINGS." AND NEC 366.

FITTINGS AND ACCESSORIES: INCLUDE COUPLINGS, OFFSETS, ELBOWS, EXPANSION JOINTS, ADAPTERS, HOLD-DOWN STRAPS, END CAPS, AND OTHER FITTINGS TO MATCH AND MATE WITH WIREWAYS AS REQUIRED FOR COMPLETE SYSTEM.

CONNECTORS: PROVIDE WIREWAY CONNECTORS SUITABLE FOR "LAY-IN" CONDUCTORS, WITH CONNECTOR COVERS PERMANENTLY ATTACHED THAT REMOVAL IS NOT NECESSARY TO UTILIZE THE LAY-IN FEATURE. CONNECTORS SHALL BE GROUNDING BUSHING, RAINTIGHT AND SEAL THE OPENING TO PREVENT WATER GETTING T INSIDE THE BOXES, JUNCTION, AND WIREWAY

WIREWAY COVERS: LAY-IN WIRE WAYS: CONSTRUCT LAY-IN WIRE WAYS WITH HINGED COVERS WITH COMPONENTS UL-LISTED, INCLUDING LENGTHS, CONNECTORS, AND FITTINGS. SELECT UNITS TO ALLOW FASTENING HINGED COVER CLOSED WITHOUT USE OF PARTS OTHER THAN STANDARD LENGTHS, FITTINGS AND CONNECTORS. CONSTRUCT UNITS TO BE CAPABLE OF SEALING COVER IN CLOSED POSITION WITH SEALING WIRE. PROVIDE WIRE WAYS WITH KNOCKOUTS.

FINISH: PROTECT SHEET METAL PARTS WITH RUST INHIBITING COATING AND BAKED ENAMEL FINISH. PLATE FINISH HARDWARE TO PREVENT CORROSION. PROTECT SCREWS INSTALLED TOWARD INSIDE OF WIREWAY WITH SPRING NUTS TO PREVENT WIRE INSULATION DAMAGE. USE PAINT ANSI61- GREY COLOR.

RAIN TIGHT WIREWAY: CONSTRUCT RAIN TIGHT LAY-IN WIRE WAYS WITH HINGED COVERS WITH COMPONENTS UL-LISTED, INCLUDING LENGTHS, CONNECTORS AND FITTINGS. DESIGN UNITS TO ALLOW FASTENING HINGED COVER CLOSED WITHOUT USE OF PARTS OTHER THAN STANDARD LENGTHS, FITTINGS AND CONNECTORS. CONSTRUCT UNITS TO BE CAPABLE OF SEALING COVER IN CLOSED POSITION WITH SEALING WIRE. PROVIDE WIREWAY UNITS WITH KNOCKOUTS ONLY IN BOTTOM OF TROUGHS.

CONSTRUCTION: 16-GAUGE GALVANIZED SHEET METAL PARTS FOR 4" X 4" TO 6" X 6" SECTIONS, AND 14-GAUGE PARTS FOR 8" X 8" AND LARGER SECTIONS. PROVIDE KNOCKOUTS ONLY IN BOTTOM OF TROUGHS, WITH SUITABLE ADAPTERS TO FACILITATE ATTACHING TO OTHER NEMA 3R ENCLOSURES. DO NOT USE GASKETING THAT CAN RIP OR TEAR DURING INSTALLATION OR WOULD COMPROMISE RAIN TIGHT CAPABILITY OF THE TROUGH AREA AND DAMAGE WIRE INSULATION.

FINISH: PROVIDE 14-GAUGE AND 16-GAUGE GALVANIZED SHEET METAL PARTS WITH CORROSION-RESISTANT PHOSPHATE PRIMER AND BAKED ENAMEL FINISH. PLATE HARDWARE TO PREVENT CORROSION.

NONMETALLIC WIREWAYS

AVAILABLE MANUFACTURERS: SUBJECT TO COMPLIANCE WITH REQUIREMENTS, MANUFACTURERS OFFERING PRODUCTS THAT MAY BE INCORPORATED INTO THE WORK INCLUDE, BUT ARE NOT LIMITED TO, THE FOLLOWING:

MANUFACTURERS: SUBJECT TO COMPLIANCE WITH REQUIREMENTS, PROVIDE PRODUCTS BY ONE OF THE FOLLOWING:

HOFFMAN.

LAMSON & SESSIONS; CARLON ELECTRICAL PRODUCTS.

DESCRIPTION: FIBERGLASS POLYESTER, EXTRUDED AND FABRICATED TO SIZE AND SHAPE INDICATED, WITH NO HOLES OR KNOCKOUTS. COVER IS GASKETED WITH OIL-RESISTANT GASKET MATERIAL AND FASTENED WITH CAPTIVE SCREWS TREATED FOR CORROSION RESISTANCE. CONNECTIONS ARE FLANGED, WITH STAINLESS-STEEL SCREWS AND OIL-RESISTANT GASKETS.

DESCRIPTION: PVC PLASTIC, EXTRUDED AND FABRICATED TO SIZE AND SHAPE INDICATED, WITH SNAP-ON COVER AND MECHANICALLY COUPLED CONNECTIONS WITH PLASTIC FASTENERS.

FITTINGS AND ACCESSORIES: INCLUDE COUPLINGS, OFFSETS, ELBOWS, EXPANSION JOINTS, ADAPTERS, HOLD-DOWN STRAPS, END CAPS, AND OTHER FITTINGS TO MATCH AND MATE WITH WIREWAYS AS REQUIRED FOR COMPLETE SYSTEM.

SURFACE RACEWAYS

SURFACE METAL RACEWAYS: GALVANIZED STEEL WITH SNAP-ON COVERS.

MANUFACTURER'S STANDARD ENAMEL FINISH IN COLOR SELECTED BY ARCHITECT.

AVAILABLE MANUFACTURERS: SUBJECT TO COMPLIANCE WITH REQUIREMENTS, MANUFACTURERS OFFERING PRODUCTS THAT MAY BE INCORPORATED INTO THE WORK INCLUDE, BUT ARE NOT LIMITED TO, THE FOLLOWING:

MANUFACTURERS: SUBJECT TO COMPLIANCE WITH REQUIREMENTS, PROVIDE PRODUCTS BY ONE OF THE FOLLOWING:

- A. Thomas & Betts Corporation.
- B. Walker Systems, Inc.; Wiremold Company (The).
- C. Wiremold Company (The); Electrical Sales Division.

MULTI OUTLET ASSEMBLIES SHALL BE USED TO PROVIDE POWER AND/OR LOW POTENTIAL SERVICES AS SHOWN ON THE BUILDING PLANS.

THE ELECTRICAL CONTRACTOR SHALL PROVIDE AND INSTALL ALL SURFACE METAL RACEWAYS AND APPROPRIATE FITTINGS TO PROVIDE SAFE AND COMPLETE INSTALLATION. THE SURFACE METAL RACEWAY AND FITTINGS SHALL BE THE TWO-PIECE WITH RECEPTACLES AND DATA OUTLETS (IF ANY) AS INDICATED.

WHEN POWER AND DATA ARE INDICATED, THE RACEWAY SHALL AFFORD THE CAPABILITY OF BEING DIVIDED INTO TWO EQUAL BUT SEPARATE WIRING COMPARTMENTS TO FACILITATE INSTALLATION OF POWER AND LOW POTENTIAL WIRING. "SEPARATE COMPARTMENTS ARE TO BE IDENTIFIED BY SHARPLY CONTRASTING COLORS OF THE INTERIOR FINISH OF THE DIVIDER."

A FULL LINE OF FITTINGS FOR THE SURFACE METAL RACEWAY SHALL BE AVAILABLE. THIS SHALL INCLUDE BUT NOT LIMITED TO ELBOWS (90, INTERNAL AND EXTERNAL), COUPLINGS FOR JOINING RACEWAY SECTIONS, WIRE CLIPS FOR HOLDING CONDUCTORS OR CABLES IN PLACE, BLANK END FITTINGS FOR CLOSING OPEN ENDS OF THE RACEWAY, TRANSITION CONNECTORS TO OTHER SURFACE METAL COMMUNICATIONS (IF ANY). ALL OPENINGS SHALL BE GROMMET. VOICE/DATA CONNECTIONS (IF ANY) SHALL BE PROVIDED WITH INTERCHANGEABLE LAN ADAPTERS. WHEN POWER AND DATA ARE INDICATED, DEVICE BRACKETS TO INSTALL SINGLE OR TWO GANG DEVICES WITHIN THE RACEWAY AND COMBINATION RECEPTACLE AND TELEPHONE OUTLET COVERS SHALL BE AVAILABLE.

THE SURFACE METAL RACEWAY AND FITTINGS SHALL MEET ALL REQUIREMENTS OF THE NEC ARTICLE 376 AND 380, AND SHALL BE LISTED BY UNDERWRITER'S LABORATORIES, INC. IN FULL COMPLIANCE WITH THEIR STANDARD FOR SURFACE METAL RACEWAYS AND FITTINGS (UL-5).

MULTI OUTLET ASSEMBLIES SHALL BE WIREMOLD 2000 SERIES WITH 5-15R SIMPLEX RECEPTACLES 18" ON CENTER.

VERIFY FINISH COLOR WITH ARCHITECT.

SURFACE NONMETALLIC RACEWAYS: TWO-PIECE CONSTRUCTION, MANUFACTURED OF RIGID PVC WITH TEXTURE AND COLOR SELECTED BY ARCHITECT FROM MANUFACTURER'S STANDARD COLORS.

AVAILABLE MANUFACTURERS: SUBJECT TO COMPLIANCE WITH REQUIREMENTS, MANUFACTURERS OFFERING PRODUCTS THAT MAY BE INCORPORATED INTO THE WORK INCLUDE, BUT ARE NOT LIMITED TO, THE FOLLOWING:

MANUFACTURERS: SUBJECT TO COMPLIANCE WITH REQUIREMENTS, PROVIDE PRODUCTS BY ONE OF THE FOLLOWING:

- A. Butler Manufacturing Company; Walker Division.
- B. Enduro Systems, Inc.; Composite Products Division.
- C. Hubbell Incorporated; Wiring Device-Kellems Division.
- D. Lamson & Sessions; Carlon Electrical Products.
- E. Panduit Corp.
- F. Walker Systems, Inc.; Wiremold Company (The).
- G. Wiremold Company (The); Electrical Sales Division.

MULTI OUTLET ASSEMBLIES SHALL BE USED TO PROVIDE POWER AND/OR LOW POTENTIAL SERVICES AS SHOWN ON THE BUILDING PLANS.

THE ELECTRICAL CONTRACTOR SHALL PROVIDE AND INSTALL ALL SURFACE METAL RACEWAYS AND APPROPRIATE FITTINGS TO PROVIDE SAFE AND COMPLETE INSTALLATION. THE SURFACE METAL RACEWAY AND FITTINGS SHALL BE THE TWO-PIECE WITH RECEPTACLES AND DATA OUTLETS (IF ANY) AS INDICATED.

WHEN POWER AND DATA ARE INDICATED, THE RACEWAY SHALL AFFORD THE CAPABILITY OF BEING DIVIDED INTO TWO EQUAL BUT SEPARATE WIRING COMPARTMENTS TO FACILITATE INSTALLATION OF POWER AND LOW POTENTIAL WIRING. "SEPARATE COMPARTMENTS ARE TO BE IDENTIFIED BY SHARPLY CONTRASTING COLORS OF THE INTERIOR FINISH OF THE DIVIDER."

A FULL LINE OF FITTINGS FOR THE SURFACE METAL RACEWAY SHALL BE AVAILABLE. THIS SHALL INCLUDE BUT NOT LIMITED TO ELBOWS (90, INTERNAL AND EXTERNAL), COUPLINGS FOR JOINING RACEWAY SECTIONS, WIRE CLIPS FOR HOLDING CONDUCTORS OR CABLES IN PLACE, BLANK END FITTINGS FOR CLOSING OPEN ENDS OF THE RACEWAY, TRANSITION CONNECTORS TO OTHER SURFACE METAL COMMUNICATIONS (IF ANY). ALL OPENINGS SHALL BE GROMMET. VOICE/DATA CONNECTIONS (IF ANY) SHALL BE PROVIDED WITH INTERCHANGEABLE LAN ADAPTERS. WHEN POWER AND DATA ARE INDICATED, DEVICE BRACKETS TO INSTALL SINGLE OR TWO GANG DEVICES WITHIN THE RACEWAY AND COMBINATION RECEPTACLE AND TELEPHONE OUTLET COVERS SHALL BE AVAILABLE.

THE SURFACE NONMETAL RACEWAY AND FITTINGS SHALL MEET ALL REQUIREMENTS OF THE NEC ARTICLE 376 AND 380, AND SHALL BE LISTED BY UNDERWRITER'S LABORATORIES, INC. IN FULL COMPLIANCE WITH THEIR STANDARD FOR SURFACE METAL RACEWAYS AND FITTINGS (UL-5).

MULTI OUTLET ASSEMBLIES SHALL BE WIREMOLD NM2000 SERIES WITH 5-15R SIMPLEX RECEPTACLES 18" ON CENTER.

VERIFY FINISH COLOR WITH ARCHITECT.

BOXES, ENCLOSURES, AND CABINETS

MANUFACTURERS: SUBJECT TO COMPLIANCE WITH REQUIREMENTS, PROVIDE PRODUCTS BY ONE OF THE FOLLOWING:

COOPER CROUSE-HINDS; DIV. OF COOPER INDUSTRIES, INC.

EGS/APPLETON ELECTRIC.

ERICKSON ELECTRICAL EQUIPMENT COMPANY.

HOFFMAN.

HUBBELL INCORPORATED; KILLARK ELECTRIC MANUFACTURING CO. DIVISION.

O-Z/GEDNEY; A UNIT OF GENERAL SIGNAL.

RACO; A HUBBELL COMPANY.

ROBROY INDUSTRIES, INC.; ENCLOSURE DIVISION.

SCOTT FETZER CO.; ADALET DIVISION.

SPRING CITY ELECTRICAL MANUFACTURING COMPANY.

THOMAS & BETTS CORPORATION.

WALKER SYSTEMS, INC.; WIREMOLD COMPANY (THE).

WOODHEAD, DANIEL COMPANY; WOODHEAD INDUSTRIES, INC. SUBSIDIARY.

SHEET METAL OUTLET AND DEVICE BOXES: NEMA OS 1.

CAST-METAL OUTLET AND DEVICE BOXES: NEMA FB 1, ALUMINUM, TYPE FD, WITH GASKETED COVER.

NONMETALLIC OUTLET AND DEVICE BOXES: NEMA OS 2.

METAL FLOOR BOXES: CAST OR SHEET METAL RECTANGULAR.

NONMETTALIC FLOOR BOXES: CAST OR SHEET METAL RECTANGULAR.

SMALL SHEET METAL PULL AND JUNCTION BOXES: NEMA OS 1.

CAST-METAL ACCESS, PULL, AND JUNCTION BOXES: NEMA FB 1, GALVANIZED, CAST IRON WITH GASKETED COVER.

HINGED-COVER ENCLOSURES: NEMA 250, TYPE 1, WITH CONTINUOUS-HINGE COVER WITH FLUSH LATCH, UNLESS OTHERWISE INDICATED.

METAL ENCLOSURES: STEEL, FINISHED INSIDE AND OUT WITH MANUFACTURER'S STANDARD ENAMEL.

NONMETALLIC ENCLOSURES: PLASTIC.

CABINETS:

NEMA 250, TYPE 1, GALVANIZED-STEEL BOX WITH REMOVABLE INTERIOR PANEL AND REMOVABLE FRONT, FINISHED INSIDE AND OUT WITH MANUFACTURER'S STANDARD ENAMEL.

HINGED DOOR IN FRONT COVER WITH FLUSH LATCH AND CONCEALED HINGE.

KEY LATCH TO MATCH PANELBOARDS.

METAL BARRIERS TO SEPARATE WIRING OF DIFFERENT SYSTEMS AND VOLTAGE.

ACCESSORY FEET WHERE REQUIRED FOR FREESTANDING EQUIPMENT.

HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

DESCRIPTION: COMPLY WITH SCTE 77.

CONFIGURATION: UNITS SHALL BE DESIGNED FOR FLUSH BURIAL AND HAVE CLOSED BOTTOM, UNLESS OTHERWISE INDICATED.

COLOR OF FRAM AND COVER: GREEN.

COVER: WEATHERPROOF, SECURED BY TAMPER-RESISTANT LOCKING DEVICES AND HAVING STRUCTURAL LOAD RATING CONSISTENT WITH ENCLOSURE.

COVER FINISH: NONSKID FINISH SHALL HAVE A MINIMUM COEFFICIENT OF FRICTION OF 0.50.

COVER LEGEND: MOLDED LETTERING, "ELECTRIC." AS INDICATED FOR EACH SERVICE.

CONDUIT ENTRANCE PROVISIONS: CONDUIT-TERMINATING FITTINGS SHALL MATE WITH ENTERING DUCTS FOR SECURE, FIXED INSTALLATION IN ENCLOSURE WALL.

HANDHOLES 12 INCHES (304.8 MM) WIDE BY 24 INCHES (609.6 MM) LONG AND LARGER SHALL HAVE INSERTS FOR CABLE RACKS AND PULLING-IN IRONS INSTALLED BEFORE CONCRETE IS POURED.

POLYMER-CONCRETE HANDHOLES AND BOXES WITH POLYMER-CONCRETE COVER: MOLDED OF SAND AND AGGREGATE, BOUND TOGETHER WITH POLYMER RESIN, AND REINFORCED WITH STEEL OR FIBERGLASS OR A COMBINATION OF THE TWO.

AVAILABLE MANUFACTURERS: SUBJECT TO COMPLIANCE WITH REQUIREMENTS, MANUFACTURERS OFFERING PRODUCTS THAT MAY BE INCORPORATED INTO THE WORK INCLUDE, BUT ARE NOT LIMITED TO, THE FOLLOWING:

- A. Armorcast Products Company.
- B. Carson Industries LLC.
- C. CDR Systems Corporation.

D. NewBasis.

FIBERGLASS HANDHOLES AND BOXES WITH POLYMER-CONCRETE FRAME AND COVER:
SHEET-MOLDED, FIBERGLASS-REINFORCED, POLYESTER-RESIN ENCLOSURE JOINED TO
POLYMER-CONCRETE TOP RING OR FRAME.

AVAILABLE MANUFACTURERS: SUBJECT TO COMPLIANCE WITH REQUIREMENTS,
MANUFACTURERS OFFERING PRODUCTS THAT MAY BE INCORPORATED INTO THE WORK
INCLUDE, BUT ARE NOT LIMITED TO, THE FOLLOWING:

- A. Armorcast Products Company.
- B. Carson Industries LLC.
- C. Christy Concrete Products.
- D. Synertech Moulded Products, Inc.; a division of Oldcastle Precast.

SLEEVES FOR RACEWAYS

STEEL PIPE SLEEVES: ASTM A53/A53M, TYPE E, GRADE B, SCHEDULE 40, GALVANIZED STEEL, PLAIN ENDS.

CAST-IRON PIPE SLEEVES: CAST OR FABRICATED "WALL PIPE," EQUIVALENT TO DUCTILE-IRON PRESSURE PIPE, WITH PLAIN ENDS AND INTEGRAL WATER STOP, UNLESS OTHERWISE INDICATED.

SLEEVES FOR RECTANGULAR OPENINGS: GALVANIZED SHEET STEEL WITH MINIMUM 0.052-OR 0.138-INCH THICKNESS AS INDICATED AND OF LENGTH TO SUIT APPLICATION.

COORDINATE SLEEVE SELECTION AND APPLICATION WITH SELECTION AND APPLICATION OF FIRESTOPPING SPECIFIED IN DIVISION 07 SECTION "PENETRATION FIRESTOPPING."

SLEEVE SEALS

AVAILABLE MANUFACTURERS: SUBJECT TO COMPLIANCE WITH REQUIREMENTS, MANUFACTURERS OFFERING PRODUCTS THAT MAY BE INCORPORATED INTO THE WORK INCLUDE, BUT ARE NOT LIMITED TO, THE FOLLOWING:

ADVANCE PRODUCTS & SYSTEMS, INC.

CALPICO, INC.

METRAFLEX CO.

PIPELINE SEAL AND INSULATOR, INC.

DESCRIPTION: MODULAR SEALING DEVICE, DESIGNED FOR FIELD ASSEMBLY, TO FILL ANNULAR SPACE BETWEEN SLEEVE AND CABLE.

SEALING ELEMENTS: EPDM INTERLOCKING LINKS SHAPED TO FIT SURFACE OF CABLE OR CONDUIT. INCLUDE TYPE AND NUMBER REQUIRED FOR MATERIAL AND SIZE OF RACEWAY OR CABLE.

PRESSURE PLATES: PLASTIC. INCLUDE TWO FOR EACH SEALING ELEMENT.

CONNECTING BOLTS AND NUTS: CARBON STEEL WITH CORROSION-RESISTANT COATING OF LENGTH REQUIRED TO SECURE PRESSURE PLATES TO SEALING ELEMENTS. INCLUDE ONE FOR EACH SEALING ELEMENT.

SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

HANDHOLE AND PULL-BOX PROTOTYPE TEST: TEST PROTOTYPES OF HANDHOLES AND BOXES FOR COMPLIANCE WITH SCTE 77. STRENGTH TESTS SHALL BE FOR SPECIFIED TIER RATINGS OF PRODUCTS SUPPLIED.

TESTS OF MATERIALS SHALL BE PERFORMED BY A INDEPENDENT TESTING AGENCY.

STRENGTH TESTS OF COMPLETE BOXES AND COVERS SHALL BE BY EITHER AN INDEPENDENT TESTING AGENCY OR MANUFACTURER. A QUALIFIED REGISTERED PROFESSIONAL ENGINEER SHALL CERTIFY TESTS BY MANUFACTURER.

TESTING MACHINE PRESSURE GAGES SHALL HAVE CURRENT CALIBRATION CERTIFICATION COMPLYING WITH ISO 9000 AND ISO 10012, AND TRACEABLE TO NIST STANDARDS.

PART 3 EXECUTION

203.01 RACEWAY APPLICATION

OUTDOORS: APPLY RACEWAY PRODUCTS AS SPECIFIED BELOW, UNLESS OTHERWISE INDICATED IN DRAWINGS:

ROOF-TOP CONDUIT PENETRATING THROUGH ROOF: RAL.

ABOVEGROUND, OTHERWISE: RGS.

UNDERGROUND:

- A. Primary conduits to utility pad-mounted transformer: per Utility Standards.
- B. RNC, Type EPC-40-PVC, direct buried

CONNECTION TO VIBRATING EQUIPMENT (INCLUDING TRANSFORMERS AND HYDRAULIC, PNEUMATIC, ELECTRIC SOLENOID, OR MOTOR-DRIVEN EQUIPMENT): LFMC LIMITED TO $\leq 72"$.

BOXES AND ENCLOSURES, ABOVEGROUND: NEMA 250, TYPE 3R.

APPLICATION OF HANDHOLES AND BOXES FOR UNDERGROUND WIRING:

- A. Handholes and Pull Boxes in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Non-deliberate Loading by Heavy Vehicles: Polymer concrete, SCTE 77, Tier 15 structural load rating.
- B. Handholes and Pull Boxes in Sidewalk and Similar Applications with a Safety Factor for Non-Deliberate Loading by Vehicles: Polymer-concrete units, SCTE 77, Tier 8 structural load rating.
- C. Handholes and Pull Boxes Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin structurally tested according to SCTE 77 with 3000-lbf vertical loading.

COMPLY WITH THE FOLLOWING INDOOR APPLICATIONS, UNLESS OTHERWISE INDICATED IN DRAWINGS:

EXPOSED, NOT SUBJECT TO PHYSICAL DAMAGE: IMC.

EXPOSED AND SUBJECT TO SEVERE PHYSICAL DAMAGE: RIGID STEEL CONDUIT. INCLUDES RACEWAYS IN THE FOLLOWING LOCATIONS:

- A. Mechanical rooms.
- B. Central Plants

CONCEALED IN CEILINGS AND INTERIOR WALLS AND PARTITIONS:

- A. Trade size ≤ 1 -inch: EMT or IMC.
- B. Trade size > 1 -inch: IMC or RGS.

CONNECTION TO VIBRATING EQUIPMENT (INCLUDING TRANSFORMERS AND HYDRAULIC, PNEUMATIC, ELECTRIC SOLENOID, OR MOTOR-DRIVEN EQUIPMENT):

- A. At dry locations $\geq 84"$ above finished floor to bottom of equipment: FMC
- B. Otherwise: LFMC.

DAMP OR WET LOCATIONS: RGS, RAL, OR IMC.

RACEWAYS FOR COMMUNICATIONS: EMT OR IMC.

BOXES AND ENCLOSURES: NEMA 250, TYPE 1, EXCEPT USE NEMA 250, TYPE 4, GALVANIZED STEEL IN DAMP OR WET LOCATIONS, UNLESS OTHERWISE NOTED ON DRAWINGS.

MINIMUM RACEWAY SIZE:

POWER AND FIRE ALARM:

- A. Above grade: 3/4-inch trade size.
- B. Below grade: 1-inch trade size.

COMMUNICATION:

- A. Above grade: 1-inch trade size.
- B. Below grade: 1-1/2-inch trade size.

RACEWAY FITTINGS: COMPATIBLE WITH RACEWAYS AND SUITABLE FOR USE AND LOCATION.
RIGID AND INTERMEDIATE STEEL CONDUIT: USE THREADED RIGID STEEL CONDUIT FITTINGS, UNLESS OTHERWISE INDICATED.

PVC EXTERNALLY COATED, RIGID STEEL CONDUITS: USE ONLY FITTINGS LISTED FOR USE WITH THAT MATERIAL. PATCH AND SEAL ALL JOINTS, NICKS, AND SCRAPES IN PVC COATING AFTER INSTALLING CONDUITS AND FITTINGS. USE SEALANT RECOMMENDED BY FITTING MANUFACTURER.

DO NOT INSTALL ALUMINUM CONDUITS IN CONTACT WITH CONCRETE.

INSTALLATION

INSTALL PRODUCTS IN ACCORDANCE WITH MANUFACTURER'S INSTRUCTIONS, NEC 366, NEC 380, AND NEC 376. COMPLY WITH NECA 1 FOR INSTALLATION REQUIREMENTS APPLICABLE TO PRODUCTS SPECIFIED IN PART 2 EXCEPT WHERE REQUIREMENTS ON DRAWINGS OR IN THIS ARTICLE ARE STRICTER.

USE FLAT-HEAD SCREWS, CLIPS, AND STRAPS TO FASTEN RACEWAY BASE TO SURFACES. MOUNT PLUMB AND LEVEL.

USE SUITABLE INSULATING BUSHINGS AND INSERTS AT CONNECTIONS TO OUTLETS AND CORNER FITTINGS.

WIREWAY AND AUXILIARY GUTTER SUPPORTS: PROVIDE STEEL CHANNEL AS SPECIFIED IN SECTION 260529.

CLOSE ENDS OF WIREWAY AND UNUSED CONDUIT OPENINGS.

GROUND AND BOND RACEWAY AND WIREWAY UNDER PROVISIONS OF SECTION 260526.

KEEP RACEWAYS AT LEAST 6 INCHES (152.4 MM) AWAY FROM PARALLEL RUNS OF FLUES AND STEAM OR HOT-WATER PIPES. INSTALL HORIZONTAL RACEWAY RUNS ABOVE WATER AND STEAM PIPING.

COMPLETE RACEWAY INSTALLATION BEFORE STARTING CONDUCTOR INSTALLATION.

SUPPORT RACEWAYS AS SPECIFIED IN DIVISION 26 SECTION "HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS."

ARRANGE STUB-UPS SO CURVED PORTIONS OF BENDS ARE NOT VISIBLE ABOVE THE FINISHED SLAB.

INSTALL NO MORE THAN THE EQUIVALENT OF THREE 90-DEGREE BENDS IN ANY CONDUIT RUN EXCEPT FOR COMMUNICATIONS CONDUITS, FOR WHICH FEWER BENDS ARE ALLOWED.

CONCEAL CONDUIT AND EMT WITHIN FINISHED WALLS, CEILINGS, AND FLOORS, UNLESS OTHERWISE INDICATED.

RACEWAYS EMBEDDED IN SLABS:

RUN CONDUIT LARGER THAN 1-INCH TRADE SIZE, PARALLEL OR AT RIGHT ANGLES TO MAIN REINFORCEMENT. WHERE AT RIGHT ANGLES TO REINFORCEMENT, PLACE CONDUIT CLOSE TO SLAB SUPPORT.

ARRANGE RACEWAYS TO CROSS BUILDING EXPANSION JOINTS AT RIGHT ANGLES WITH EXPANSION FITTINGS.

CHANGE FROM ENT TO RNC, TYPE EPC-40-PVC, RIGID STEEL CONDUIT, OR IMC BEFORE RISING ABOVE THE FLOOR.

THREADED CONDUIT JOINTS, EXPOSED TO WET, DAMP, CORROSIVE, OR OUTDOOR CONDITIONS: APPLY LISTED COMPOUND TO THREADS OF RACEWAY AND FITTINGS BEFORE MAKING UP JOINTS. FOLLOW COMPOUND MANUFACTURER'S WRITTEN INSTRUCTIONS.

RACEWAY TERMINATIONS AT LOCATIONS SUBJECT TO MOISTURE OR VIBRATION: USE INSULATING BUSHINGS TO PROTECT CONDUCTORS, INCLUDING CONDUCTORS SMALLER THAN NO. 4 AWG.

INSTALL PULL WIRES IN EMPTY RACEWAYS. USE POLYPROPYLENE OR MONOFILAMENT PLASTIC LINE WITH NOT LESS THAN 200-LB TENSILE STRENGTH. LEAVE AT LEAST 12 INCHES (304.8 MM) OF SLACK AT EACH END OF PULL WIRE.

RACEWAYS FOR OPTICAL FIBER AND COMMUNICATIONS CABLE: INSTALL RACEWAYS, METALLIC AND NONMETALLIC, RIGID AND FLEXIBLE, AS FOLLOWS:

3/4-INCH TRADE SIZE AND SMALLER: INSTALL RACEWAYS IN MAXIMUM LENGTHS OF 50 FEET (1524 CM).

1-INCH TRADE SIZE AND LARGER: INSTALL RACEWAYS IN MAXIMUM LENGTHS OF 75 FEET (2286 CM).

INSTALL WITH A MAXIMUM OF TWO 90-DEGREE BENDS OR EQUIVALENT FOR EACH LENGTH OF RACEWAY UNLESS DRAWINGS SHOW STRICTER REQUIREMENTS. SEPARATE LENGTHS WITH PULL OR JUNCTION BOXES OR TERMINATIONS AT DISTRIBUTION FRAMES OR CABINETS WHERE NECESSARY TO COMPLY WITH THESE REQUIREMENTS.

INSTALL RACEWAY SEALING FITTINGS AT SUITABLE, APPROVED, AND ACCESSIBLE LOCATIONS AND FILL THEM WITH LISTED SEALING COMPOUND. FOR CONCEALED RACEWAYS, INSTALL EACH FITTING IN A FLUSH STEEL BOX WITH A BLANK COVER PLATE HAVING A FINISH SIMILAR TO THAT OF ADJACENT PLATES OR SURFACES. INSTALL RACEWAY SEALING FITTINGS AT THE FOLLOWING POINTS:

WHERE CONDUITS PASS FROM WARM TO COLD LOCATIONS, SUCH AS BOUNDARIES OF REFRIGERATED SPACES.

WHERE OTHERWISE REQUIRED BY NFPA 70.

EXPANSION-JOINT FITTINGS FOR RNC: INSTALL IN EACH RUN OF ABOVEGROUND CONDUIT THAT IS LOCATED WHERE ENVIRONMENTAL TEMPERATURE CHANGE MAY EXCEED 30 DEG F, AND THAT HAS STRAIGHT-RUN LENGTH THAT EXCEEDS 25 FEET (762 CM).

INSTALL EXPANSION-JOINT FITTINGS FOR EACH OF THE FOLLOWING LOCATIONS, AND PROVIDE TYPE AND QUANTITY OF FITTINGS THAT ACCOMMODATE TEMPERATURE CHANGE LISTED FOR LOCATION:

- A. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
- B. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
- C. Indoor Spaces: Connected with the Outdoors without Physical Separation: 125 deg F temperature change.
- D. Attics: 135 deg F temperature change.

INSTALL FITTING(S) THAT PROVIDE EXPANSION AND CONTRACTION FOR AT LEAST 0.00041 INCH (0.01 MM) PER FOOT OF LENGTH OF STRAIGHT RUN PER DEG F OF TEMPERATURE CHANGE.

INSTALL EACH EXPANSION-JOINT FITTING WITH POSITION, MOUNTING, AND PISTON SETTING SELECTED ACCORDING TO MANUFACTURER'S WRITTEN INSTRUCTIONS FOR CONDITIONS AT SPECIFIC LOCATION AT THE TIME OF INSTALLATION.

FLEXIBLE CONDUIT CONNECTIONS: USE MAXIMUM OF 72 INCHES (1828.8 MM) OF FLEXIBLE CONDUIT FOR RECESSED AND SEMI-RECESSED LIGHTING FIXTURES OF 3/4 INCH (19.05 MM) SIZE MINIMUM, EQUIPMENT SUBJECT TO VIBRATION, NOISE TRANSMISSION, OR MOVEMENT; AND FOR TRANSFORMERS AND MOTORS ARE LIMITED TO NO MORE THAN 4 FEET (121.92 CM) IN LENGTH.

USE LFMC IN DAMP OR WET LOCATIONS SUBJECT TO SEVERE PHYSICAL DAMAGE.

USE LFMC OR LFNC IN DAMP OR WET LOCATIONS NOT SUBJECT TO SEVERE PHYSICAL DAMAGE.

RECESSED BOXES IN MASONRY WALLS: SAW-CUT OPENING FOR BOX IN CENTER OF CELL OF MASONRY BLOCK AND INSTALL BOX FLUSH WITH SURFACE OF WALL.

SET METAL FLOOR BOXES LEVEL AND FLUSH WITH FINISHED FLOOR SURFACE.

SET NONMETALLIC FLOOR BOXES LEVEL. TRIM AFTER INSTALLATION TO FIT FLUSH WITH FINISHED FLOOR SURFACE.

LABEL AND MARKED ALL JUNCTION BOXES, PULL BOXES, CABINETS AND CONDUITS LEAVING AND ENTERING ANY OF THE BOXES, CABINETS, AND PANELBOARDS.

BOXES, JUNCTION, PULL, CABINETS, PANELBOARDS AND OTHER CABINETS SHALL BE RIGIDLY SUPPORTED WITH CROSS BARS, UNISTRUT, ALL-THREAD, AND ANY APPROVED THAT WILL PREVENT FROM MOVING.

INSTALLATION OF UNDERGROUND CONDUIT

DIRECT-BURIED CONDUIT:

EXCAVATE TRENCH BOTTOM TO PROVIDE FIRM AND UNIFORM SUPPORT FOR CONDUIT. PREPARE TRENCH BOTTOM AS SPECIFIED IN DIVISION 31 SECTION "EARTH MOVING" FOR PIPE LESS THAN 6 INCHES (152.4 MM) IN NOMINAL DIAMETER.

FOR SERVICE ENTRANCE CONDUIT SHALL BE BURIED NOT LESS 48 INCHES (1219.2 MM) DEPTH FROM THE TOP OF THE CONDUIT TO FINISH GRADE. FOR FEEDER CONDUIT SHALL BE BURIED NOT LESS 36 INCHES (914.4 MM) DEPTH FROM THE TOP OF THE CONDUIT TO FINISH GRADE. FOR BRANCH CONDUIT SHALL BE BURIED NOT LESS 24 INCHES (609.6 MM) DEPTH FROM THE TOP OF THE CONDUIT TO FINISH GRADE UNLESS SUBJECT TO VEHICLE TRAFFIC. THE CONDUITS ARE TO BE LEVEL TO THE GROUND.

INSTALL BACKFILL AS SPECIFIED IN DIVISION 31 SECTION "EARTH MOVING."

AFTER INSTALLING CONDUIT, THE CONDUIT SHALL BE SUPPORTED ANCHOR TO THE GROUND WITH A 3/4 INCH EMT CROSSWAYS ON EVERY 4 FEET (121.92 CM) INTERVALS THEN BACKFILL AND COMPACT WITH SAND FILL. START AT TIE-IN POINT, AND WORK TOWARD END OF CONDUIT RUN, LEAVING CONDUIT AT END OF RUN FREE TO MOVE WITH EXPANSION AND CONTRACTION AS TEMPERATURE CHANGES DURING THIS PROCESS. FIRMLY HAND TAMP BACKFILL AROUND CONDUIT TO PROVIDE MAXIMUM SUPPORTING STRENGTH. AFTER PLACING CONTROLLED BACKFILL TO WITHIN 12 INCHES (304.8 MM) OF FINISHED GRADE, MAKE FINAL CONDUIT CONNECTION AT END OF RUN AND COMPLETE BACKFILLING WITH 95% COMPACTION.

INSTALL MANUFACTURED SWEEP 90-DEGREE RMC DUCT ELBOWS FOR STUB-UPS AT POLES AND EQUIPMENT AND AT BUILDING ENTRANCES THROUGH THE FLOOR, UNLESS OTHERWISE INDICATED. ENCASE ELBOWS FOR STUB-UP DUCTS THROUGHOUT THE LENGTH OF THE ELBOW.

INSTALL MANUFACTURED RIGID STEEL CONDUIT ELBOWS FOR STUB-UPS AT POLES AND EQUIPMENT AND AT BUILDING ENTRANCES THROUGH THE FLOOR.

- A. Couple steel conduits to ducts with adapters designed for this purpose and encase coupling with 3 inches (76.2 mm) of concrete.
- B. For stub-ups at equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches (1524 mm) from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.
- C. Wrap elbow and first 12" of vertical conduit with Scotch #51 tape (no substitutions), 20-mil thick, 4" wide tape applied two full laps at each start and end of wrap, and 1" overlap for intermediate laps.
- D. Use special-radius elbow, minimum 24" radius unless otherwise indicated on Drawings.

WARNING PLANKS: BURY WARNING PLANKS APPROXIMATELY 12 INCHES (304.8 MM) ABOVE DIRECT-BURIED CONDUITS, PLACING THOSE 24 INCHES (609.6 MM) O.C. ALIGN PLANKS ALONG THE WIDTH AND ALONG THE CENTERLINE OF CONDUIT.

INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

INSTALL HANDHOLES AND BOXES LEVEL AND PLUMB AND WITH ORIENTATION AND DEPTH COORDINATED WITH CONNECTING CONDUITS TO MINIMIZE BENDS AND DEFLECTIONS REQUIRED FOR PROPER ENTRANCES.

UNLESS OTHERWISE INDICATED, SUPPORT UNITS ON A LEVEL BED OF CRUSHED STONE OR GRAVEL, GRADED FROM 1/2-INCH SIEVE TO NO. 4 SIEVE AND COMPACTED TO SAME DENSITY AS ADJACENT UNDISTURBED EARTH.

ELEVATION: IN PAVED AREAS, SET SO COVER SURFACE WILL BE FLUSH WITH FINISHED GRADE. SET COVERS OF OTHER ENCLOSURES 1 INCH (25.4 MM) ABOVE FINISHED GRADE.

INSTALL REMOVABLE HARDWARE, INCLUDING PULLING EYES, CABLE STANCHIONS, CABLE ARMS, AND INSULATORS, AS REQUIRED FOR INSTALLATION AND SUPPORT OF CABLES AND CONDUCTORS AND AS INDICATED. SELECT ARM LENGTHS TO BE LONG ENOUGH TO PROVIDE SPARE SPACE FOR FUTURE CABLES, BUT SHORT ENOUGH TO PRESERVE ADEQUATE WORKING CLEARANCES IN THE ENCLOSURE.

FIELD-CUT OPENINGS FOR CONDUITS ACCORDING TO ENCLOSURE MANUFACTURER'S WRITTEN INSTRUCTIONS. CUT WALL OF ENCLOSURE WITH A TOOL DESIGNED FOR MATERIAL TO BE CUT. SIZE HOLES FOR TERMINATING FITTINGS TO BE USED, AND SEAL AROUND PENETRATIONS AFTER FITTINGS ARE INSTALLED.

SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

COORDINATE SLEEVE SELECTION AND APPLICATION WITH SELECTION AND APPLICATION OF FIRESTOPPING SPECIFIED IN DIVISION 07 SECTION "PENETRATION FIRESTOPPING."

CONCRETE SLABS AND WALLS: INSTALL SLEEVES FOR PENETRATIONS UNLESS CORE-DRILLED HOLES OR FORMED OPENINGS ARE USED. INSTALL SLEEVES DURING ERECTION OF SLABS AND WALLS.

USE PIPE SLEEVES UNLESS PENETRATION ARRANGEMENT REQUIRES RECTANGULAR SLEEVED OPENING.

RECTANGULAR SLEEVE MINIMUM METAL THICKNESS:

FOR SLEEVE CROSS-SECTION RECTANGLE PERIMETER LESS THAN 50 INCHES (1270 MM) AND NO SIDE GREATER THAN 16 INCHES (406.4 MM), THICKNESS SHALL BE 0.052 INCH (1.32 MM).

FOR SLEEVE CROSS-SECTION RECTANGLE PERIMETER EQUAL TO, OR GREATER THAN, 50 INCHES (1270 MM) AND 1 OR MORE SIDES EQUAL TO, OR GREATER THAN, 16 INCHES (406.4 MM), THICKNESS SHALL BE 0.138 INCH (3.51 MM).

FIRE-RATED ASSEMBLIES: INSTALL SLEEVES FOR PENETRATIONS OF FIRE-RATED FLOOR AND WALL ASSEMBLIES UNLESS OPENINGS COMPATIBLE WITH FIRESTOP SYSTEM USED ARE FABRICATED DURING CONSTRUCTION OF FLOOR OR WALL.

CUT SLEEVES TO LENGTH FOR MOUNTING FLUSH WITH BOTH SURFACES OF WALLS.

EXTEND SLEEVES INSTALLED IN FLOORS 2 INCHES (50.8 MM) ABOVE FINISHED FLOOR LEVEL.

SIZE PIPE SLEEVES TO PROVIDE 1/4-INCH ANNULAR CLEAR SPACE BETWEEN SLEEVE AND RACEWAY UNLESS SLEEVE SEAL IS TO BE INSTALLED.

SEAL SPACE OUTSIDE OF SLEEVES WITH GROUT FOR PENETRATIONS OF CONCRETE AND MASONRY AND WITH APPROVED JOINT COMPOUND FOR GYPSUM BOARD ASSEMBLIES.

INTERIOR PENETRATIONS OF NON-FIRE-RATED WALLS AND FLOORS: SEAL ANNULAR SPACE BETWEEN SLEEVE AND RACEWAY, USING JOINT SEALANT APPROPRIATE FOR SIZE, DEPTH, AND LOCATION OF JOINT. REFER TO DIVISION 07 SECTION "JOINT SEALANTS" FOR MATERIALS AND INSTALLATION.

FIRE-RATED-ASSEMBLY PENETRATIONS: MAINTAIN INDICATED FIRE RATING OF WALLS, PARTITIONS, CEILINGS, AND FLOORS AT RACEWAY PENETRATIONS. INSTALL SLEEVES AND SEAL WITH FIRESTOP MATERIALS. COMPLY WITH DIVISION 07 SECTION "PENETRATION FIRESTOPPING."

ROOF-PENETRATION SLEEVES: SEAL PENETRATION OF INDIVIDUAL RACEWAYS WITH FLEXIBLE, BOOT-TYPE FLASHING UNITS APPLIED IN COORDINATION WITH ROOFING WORK.

ABOVEGROUND, EXTERIOR-WALL PENETRATIONS: SEAL PENETRATIONS USING SLEEVES AND MECHANICAL SLEEVE SEALS. SELECT SLEEVE SIZE TO ALLOW FOR 1-INCH ANNULAR CLEAR SPACE BETWEEN PIPE AND SLEEVE FOR INSTALLING MECHANICAL SLEEVE SEALS.

UNDERGROUND, EXTERIOR-WALL PENETRATIONS: INSTALL CAST-IRON "WALL PIPES" FOR SLEEVES. SIZE SLEEVES TO ALLOW FOR 1-INCH ANNULAR CLEAR SPACE BETWEEN RACEWAY AND SLEEVE FOR INSTALLING MECHANICAL SLEEVE SEALS.

SLEEVE-SEAL INSTALLATION

INSTALL TO SEAL UNDERGROUND, EXTERIOR WALL PENETRATIONS.

USE TYPE AND NUMBER OF SEALING ELEMENTS RECOMMENDED BY MANUFACTURER FOR RACEWAY MATERIAL AND SIZE. POSITION RACEWAY IN CENTER OF SLEEVE. ASSEMBLE MECHANICAL SLEEVE SEALS AND INSTALL IN ANNULAR SPACE BETWEEN RACEWAY AND SLEEVE. TIGHTEN BOLTS AGAINST PRESSURE PLATES THAT CAUSE SEALING ELEMENTS TO EXPAND AND MAKE WATERTIGHT SEAL.

FIRESTOPPING

APPLY FIRESTOPPING TO ELECTRICAL PENETRATIONS OF FIRE-RATED FLOOR AND WALL ASSEMBLIES TO RESTORE ORIGINAL FIRE-RESISTANCE RATING OF ASSEMBLY.

FIRESTOPPING MATERIALS AND INSTALLATION REQUIREMENTS ARE SPECIFIED IN DIVISION 07 SECTION "PENETRATION FIRESTOPPING."

PROTECTION

PROVIDE FINAL PROTECTION AND MAINTAIN CONDITIONS THAT ENSURE COATINGS, FINISHES, AND CABINETS ARE WITHOUT DAMAGE OR DETERIORATION AT TIME OF SUBSTANTIAL COMPLETION.

REPAIR DAMAGE TO GALVANIZED FINISHES WITH ZINC-RICH PAINT RECOMMENDED BY MANUFACTURER.

REPAIR DAMAGE TO PVC OR PAINT FINISHES WITH MATCHING TOUCHUP COATING RECOMMENDED BY MANUFACTURER.

END OF SECTION

26 05 43

UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

3.01 REFERENCE STANDARDS

- A. AASHTO HB - Standard Specifications for Highway Bridges; 2005, with Errata.
- B. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC); 2025.
- C. ASTM A48/A48M - Standard Specification for Gray Iron Castings; 2022.
- D. ASTM C270 - Standard Specification for Mortar for Unit Masonry; 2025b.
- E. ASTM C858 - Standard Specification for Underground Precast Concrete Utility Structures; 2019.
- F. ASTM C891 - Standard Practice for Installation of Underground Precast Concrete Utility Structures; 2020.
- G. ASTM C1037 - Standard Practice for Inspection of Underground Precast Concrete Utility Structures; 2016 (Reapproved 2024).
- H. ASTM E329 - Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection; 2025b.
- I. ISO 9000 - Quality Management Systems -- Fundamentals and Vocabulary; 2015.
- J. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit; 2020.
- K. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing; 2021.
- L. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- M. SCTE 77 - Specifications for Underground Enclosure Integrity; 2023.
- N. UL 514B - Conduit, Tubing, and Cable Fittings; Current Edition, Including All Revisions.
- O. UL 651 - Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings; Current Edition, Including All Revisions.

3.02 RELATED DOCUMENTS

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

3.03 SUMMARY

- A. This Section includes the following:
 - 1. Conduit, ducts, and duct accessories for concrete-encased duct banks.
 - 2. Hand-holes and boxes.
 - 3. Manholes.

3.04 DEFINITION

- A. RNC: Rigid nonmetallic conduit.

3.05 SUBMITTALS

- A. Product Data: For the following:
 - 1. Duct-bank materials, including separators and miscellaneous components.
 - 2. Ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
 - 3. Accessories for manholes, hand-holes, boxes.
 - 4. Warning tape.

- 5. Warning planks.
 - B. Shop Drawings for Precast or Factory-Fabricated Underground Utility Structures: Include plans, elevations, sections, details, attachments to other work, and accessories, including the following:
 - 1. Duct entry provisions, including locations and duct sizes.
 - 2. Reinforcement details.
 - 3. Frame and cover design and manhole frame support rings.
 - 4. Ladder details.
 - 5. Grounding details.
 - 6. Dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
 - 7. Joint details.
 - C. Shop Drawings for Factory-Fabricated Handholes and Boxes Other Than Precast Concrete: Include dimensioned plans, sections, and elevations, and fabrication and installation details, including the following:
 - 1. Duct entry provisions, including locations and duct sizes.
 - 2. Cover design.
 - 3. Grounding details.
 - 4. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.
 - D. Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.
 - 1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
 - 2. Drawings shall be signed and sealed by a qualified professional engineer.
 - E. Product Certificates: For concrete and steel used in pre-cast concrete manholes and handholes, as required by ASTM C858.
 - F. Qualification Data: For professional engineer and testing agency.
 - G. Source quality-control test reports.
 - H. Field quality-control test reports.
- 3.06 QUALITY ASSURANCE
- A. Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated.
 - B. Comply with ANSI C2.
 - C. Comply with NFPA 70.
- 3.07 DELIVERY, STORAGE, AND HANDLING
- A. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.
 - B. Store pre-cast concrete and other factory-fabricated underground utility structures at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.
 - C. Lift and support pre-cast concrete units only at designated lifting or supporting points.
- 3.08 PROJECT CONDITIONS
- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
 - 1. Notify Construction Manager and Owner no fewer than two (2) weeks in advance of proposed interruption of electrical service.
 - 2. Do not proceed with interruption of electrical service without Owner's written permission.

3.09 COORDINATION

- A. Coordinate layout and installation of ducts, manholes, hand-holes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.
- B. Coordinate elevations of ducts and duct-bank entrances into manholes, hand-holes, and boxes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that duct runs drain to manholes and hand-holes, and as approved by Architect.

3.10 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
- B. Furnish cable-support stanchions, arms, and insulators, and associated fasteners in quantities equal to 10 percent of quantity of each item installed.

PART 2 PRODUCTS

4.01 CONDUIT

- A. Refer to Section 26 05 33.
- B. Rigid Steel Conduit: Galvanized. Comply with ANSI C80.1.
- C. RNC: NEMA TC 2, Type EPC-40-PVC and Type EPC-80-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

4.02 NONMETALLIC DUCTS AND DUCT ACCESSORIES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. ARNCO Corp.
 - 2. Beck Manufacturing.
 - 3. Cantex, Inc.
 - 4. CertainTeed Corp.; Pipe & Plastics Group.
 - 5. Condux International, Inc.
 - 6. ElecSys, Inc.
 - 7. Electri-Flex Company.
 - 8. IPEX Inc.
 - 9. Lamson & Sessions; Carlon Electrical Products.
 - 10. Manhattan/CDT; a division of Cable Design Technologies.
 - 11. Spiraduct/AFC Cable Systems, Inc.
- B. Duct Accessories:
 - 1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used for supporting ducts during concreting or backfilling.
 - a. Carlon "Snap-N-Stac" combination spacers, interlocking type with 3" separation and reducers as required.
 - 2. Warning Tape: Underground-line warning tape specified in Division 26 Section "Identification for Electrical Systems."
 - 3. Concrete Warning Planks: Nominal 12 by 24 by 3 inches (76.2 mm) in size, manufactured from 6000-psi concrete.
 - a. Color: Red dye added to concrete during batching.
 - b. Mark each plank with "ELECTRIC" in 2-inch- high, 3/8-inch- deep letters.
- C. Concrete Encasement:
 - 1. Encased in minimum 3" of 5000 PSI conc

4.03 PRECAST CONCRETE HANDHOLES AND BOXES

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Carder Concrete Products.
 - 2. Christy Concrete Products.
 - 3. Elmhurst-Chicago Stone Co.
 - 4. Oldcastle Precast Group.
 - 5. Riverton Concrete Products; a division of Cretex Companies, Inc.
 - 6. Utility Concrete Products, LLC.
 - 7. Utility Vault Co.
 - 8. Wausau Tile, Inc.
- B. Comply with ASTM C858 for design and manufacturing processes.
- C. Structural Rating: AASHTO HB 17, H-20.
- D. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of hand-hole or box.
 - 1. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
 - 2. Frame and Cover: Weatherproof steel frame, with steel cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
 - 3. Frame and Cover: Weatherproof steel frame, with hinged steel access door assembly with tamper-resistant, captive, cover-securing bolts.
 - a. Cover Hinges: Concealed, with hold-open ratchet assembly.
 - b. Cover Handle: Recessed.
 - 4. Frame and Cover: Weatherproof aluminum frame with hinged aluminum access door assembly with tamper-resistant, captive, cover-securing bolts.
 - a. Cover Hinges: Concealed, with hold-open ratchet assembly.
 - b. Cover Handle: Recessed.
 - 5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 - 6. Cover Legend: Molded lettering.
 - 7. Configuration: Units shall be designed for flush burial and have closed bottom, unless otherwise indicated.
 - 8. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.
 - a. Extension shall provide increased depth of 12 inches (304.8 mm).
 - b. Slab: Same dimensions as bottom of enclosure and arranged to provide closure.
 - 9. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches (304.8 mm) vertically and horizontally to accommodate alignment variations.
 - a. Windows shall be located no less than 6 inches (152.4 mm) from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
 - b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
 - c. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.
 - 10. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
 - a. Type and size shall match fittings to duct or conduit to be terminated.

- b. Fittings shall align with elevations of approaching ducts and be located near interior corners of handholes to facilitate racking of cable.
- 11. Handholes 12 inches (304.8 mm) wide by 24 inches (609.6 mm) long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

4.04 HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

- A. Description: Comply with SCTE 77.
 - 1. Color: Gray.
 - 2. Configuration: Units shall be designed for flush burial and have closed bottom, unless otherwise indicated.
 - 3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
 - 4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 - 5. Cover Legend: Molded lettering, as indicated for each service.
 - 6. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
 - 7. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
 - 8. Handholes 12 inches (304.8 mm) wide by 24 inches (609.6 mm) long and larger shall have factory-installed inserts for cable racks and pulling-in irons.
- B. Polymer Concrete Handholes and Boxes with Polymer Concrete Cover: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 - a. Armorcast Products Company.
 - b. Carson Industries LLC.
 - c. CDR Systems Corporation.
 - d. NewBasis.
- C. Fiberglass Handholes and Boxes with Polymer Concrete Frame and Cover: Sheet-molded, fiberglass-reinforced, polyester resin enclosure joined to polymer concrete top ring or frame.
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 - a. Armorcast Products Company.
 - b. Carson Industries LLC.
 - c. Christy Concrete Products.
 - d. Synertech Moulded Products, Inc.; a division of Oldcastle Precast.
- D. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with covers of polymer concrete.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 - a. Carson Industries LLC.
 - b. Christy Concrete Products.
 - c. Nordic Fiberglass, Inc.

4.05 PRECAST MANHOLES

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. Carder Concrete Products.
 2. Christy Concrete Products.
 3. Elmhurst-Chicago Stone Co.
 4. Oldcastle Precast Group.
 5. Riverton Concrete Products; a division of Cretex Companies, Inc.
 6. Utility Concrete Products, LLC.
 7. Utility Vault Co.
 8. Wausau Tile, Inc.
- B. Structural Rating: AASHTO HB 17, H-20.
- C. Comply with ASTM C858 and with interlocking mating sections, complete with accessories, hardware, and features.
 1. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches (304.8 mm) vertically and horizontally to accommodate alignment variations.
 - a. Windows shall be located no less than 6 inches (152.4 mm) from interior surfaces of walls, floors, or roofs of manholes, but close enough to corners to facilitate racking of cables on walls.
 - b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
 - c. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.
 2. Duct Entrances in Manhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
 - a. Type and size shall match fittings to duct or conduit to be terminated.
 - b. Fittings shall align with elevations of approaching ducts and be located near interior corners of manholes to facilitate racking of cable.
- D. Concrete Knockout Panels: 1-1/2 to 2 inches (50.8 mm) thick, for future conduit entrance and sleeve for ground rod.
- E. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

4.06 CAST-IN-PLACE MANHOLES

- A. Description: Underground utility structures, constructed in place, complete with accessories, hardware, and features. Include concrete knockout panels for conduit entrance and sleeve for ground rod.
- B. Materials: Comply with ASTM C858 and with Division 03 Section "Cast-in-Place Concrete."

C. Structural Design Loading: As specified in Part 3 "Underground Enclosure Application" Article.

4.07 UTILITY STRUCTURE ACCESSORIES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Bilco Company (The).
 - 2. Campbell Foundry Company.
 - 3. Carder Concrete Products.
 - 4. Christy Concrete Products.
 - 5. East Jordan Iron Works, Inc.
 - 6. Elmhurst-Chicago Stone Co.
 - 7. McKinley Iron Works, Inc.
 - 8. Neenah Foundry Company.
 - 9. NewBasis.
 - 10. Oldcastle Precast Group.
 - 11. Osburn Associates, Inc.
 - 12. Pennsylvania Insert Corporation.
 - 13. Riverton Concrete Products; a division of Cretex Companies, Inc..
 - 14. Strongwell Corporation; Lenoir City Division.
 - 15. Underground Devices, Inc.
 - 16. Utility Concrete Products, LLC.
 - 17. Utility Vault Co.
 - 18. Wausau Tile, Inc.
- C. Manhole Frames, Covers, and Chimney Components: Comply with structural design loading specified for manhole.
 - 1. Frame and Cover: Weatherproof, gray cast iron complying with ASTM A48/A48M, Class 30B with milled cover-to-frame bearing surfaces; diameter, 29 inches (736.6 mm).
 - a. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 - b. Special Covers: Recess in face of cover designed to accept finish material in paved areas.
 - 2. Cover Legend: Cast in. Selected to suit system.
 - a. Legend: "ELECTRIC-LV" for duct systems with power wires and cables for systems operating at 600 V and less.
 - b. Legend: "ELECTRIC-HV" for duct systems with medium-voltage cables.
 - c. Legend: "COMMUNICATION" for communications, data, and telephone duct systems.
 - 3. Manhole Chimney Components: Precast concrete rings with dimensions matched to those of roof opening.
 - a. Mortar for Chimney Ring and Frame and Cover Joints: Comply with ASTM C270, Type M, except for quantities less than 2.0 cu. ft. where packaged mix complying with ASTM C 387, Type M, may be used.
- D. Manhole Sump Frame and Grate: ASTM A48/A48M, Class 30B, gray cast iron.
- E. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2-inch diameter eye, and 1-by 4-inch bolt.
 - 1. Working Load Embedded in 6-Inch, 4000-psi Concrete: 13,000-lbf minimum tension.
- F. Pulling Eyes in Non-concrete Walls: Eyebolt with reinforced fastening, 1-1/4-inch diameter eye, rated 2500-lbf minimum tension.

-
- G. Pulling-In and Lifting Irons in Concrete Floors: 7/8-inch diameter, hot-dip galvanized, bent steel rod; stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening.
 - 1. Ultimate Yield Strength: 40,000-lbf shear and 60,000-lbf tension.
 - H. Bolting Inserts for Concrete Utility Structure Cable Racks and Other Attachments: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2-inch ID by 2-3/4 inches (70 mm) deep, flared to 1-1/4 inches (32 mm) minimum at base.
 - 1. Tested Ultimate Pullout Strength: 12,000 lbf minimum.
 - I. Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip with 1/2-inch bolt, 5300-lbf rated pullout strength, and minimum 6800-lbf rated shear strength.
 - J. Cable Rack Assembly: Steel, hot-dip galvanized, except insulators.
 - 1. Stanchions: T-section or channel; 2-1/4-inch nominal size; punched with 14 holes on 1-1/2-inch centers for cable-arm attachment.
 - 2. Arms: 1-1/2 inches (38 mm) wide, lengths ranging from 3 inches (76.2 mm) with 450-lb minimum capacity to 18 inches (457.2 mm) with 250-lb minimum capacity. Arms shall have slots along full length for cable ties and be arranged for secure mounting in horizontal position at any vertical location on stanchions.
 - 3. Insulators: High-glaze, wet-process porcelain arranged for mounting on cable arms.
 - K. Cable Rack Assembly: Nonmetallic. Components fabricated from nonconductive, fiberglass-reinforced polymer.
 - 1. Stanchions: Nominal 36 inches (914.4 mm) high by 4 inches (101.6 mm) wide, with minimum of 9 holes for arm attachment.
 - 2. Arms: Arranged for secure, drop-in attachment in horizontal position at any location on cable stanchions, and capable of being locked in position. Arms shall be available in lengths ranging from 3 inches (76.2 mm) with 450-lb minimum capacity to 20 inches (508 mm) with 250-lb minimum capacity. Top of arm shall be nominally 4 inches (101.6 mm) wide, and arm shall have slots along full length for cable ties.
 - L. Duct-Sealing Compound: Non-hardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F. Capable of withstanding temperature of 300 deg F without slump and adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.
 - M. Fixed Manholes Ladders: Arranged for attachment to wall of manhole. Ladder and mounting brackets and braces shall be fabricated from hot-dip galvanized steel.
 - N. Cover Hooks: Heavy duty, designed for lifts 60 lbf and greater. Two required.

4.08 SOURCE QUALITY CONTROL

- A. Test and inspect precast concrete utility structures according to ASTM C1037.
- B. Non-concrete Handhole and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
 - 1. Tests of materials shall be performed by a independent testing agency.
 - 2. Strength tests of complete boxes and covers shall be by either an independent testing agency or the manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
 - 3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 EXECUTION

5.01 UNDERGROUND DUCT APPLICATION

- A. Ducts for Electrical Cables Over 600 V: RNC, NEMA Type EPC-80-PVC, in concrete-encased duct bank, unless otherwise indicated. This includes Electric Utility Primary Duct Banks.
- B. Ducts for Electrical Feeders 600 V and Less: RNC, NEMA Type EPC-80 -PVC, in concrete-encased duct bank, unless otherwise indicated.
- C. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: RNC, NEMA Type EPC-80-PVC, installed in concrete-encased duct bank, unless otherwise indicated.
- D. Wrap all RGS with 2 layers of Scotch wrap which will come in contact with concrete.

5.02 UNDERGROUND ENCLOSURE APPLICATION

- A. Handholes and Boxes for 600 V and Less:
 - 1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, H-20 structural load rating.
 - 2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Non-deliberate Loading by Heavy Vehicles: Precast concrete, AASHTO HB 17, H-20 structural load rating.
 - 3. Units in Sidewalk and Similar Applications with a Safety Factor for Non-deliberate Loading by Vehicles: Precast concrete, AASHTO HB 17, H-10 structural load rating.
 - 4. Units Subject to Light-Duty Pedestrian Traffic only: Fiberglass-reinforced polyester resin structurally tested according to SCTE 77 with 3000-lbf vertical loading.
- B. Manholes: Precast or cast-in-place concrete.
 - 1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating according to AASHTO HB 17.
 - 2. Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: H-10 load rating according to AASHTO HB 17.

5.03 EARTHWORK

- A. Excavation and Backfill: Comply with Division 31 Section "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.
- B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.
- C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary top soiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Division 32 Sections "Turf and Grasses" and "Plants."
- D. Cut and patch existing pavement in the path of underground ducts and utility structures according to Division 01 Section "Cutting and Patching."

5.04 DUCT INSTALLATION

- A. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions.
- B. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches (1219.2 mm), both horizontally and vertically, at other locations, unless otherwise indicated and 25ft horizontally for above 600v cables.
- C. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.

- D. Duct Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches (254 mm) o.c. for 5-inch ducts, and vary proportionately for other duct sizes.
 - 1. Begin change from regular spacing to end-bell spacing 10 feet (304.8 cm) from the end bell without reducing duct line slope and without forming a trap in the line.
 - 2. Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to manhole or handhole.
 - 3. Grout end bells into structure walls from both sides to provide watertight entrances.
- E. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit and RMC sweep 90 degree elbow at least 10 feet (304.8 cm) outside the building wall without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building walls as specified in Division 26 Section "Common Work Results for Electrical."
- F. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.
- G. Pulling Cord: Install 100-lbf- test nylon cord in ducts, including spares.
- H. Concrete-Encased Ducts: Support ducts on duct separators.
 - 1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not more than 6 feet (182.88 cm) apart. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches (152.4 mm) between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
 - 2. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
 - a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations or use other specific measures to prevent expansion-contraction damage.
 - b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing rod dowels extending 18 inches (457.2 mm) into concrete on both sides of joint near corners of envelope.
 - 3. Pouring Concrete: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.
 - 4. Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
 - 5. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
 - 6. Minimum Space between Ducts: 3 inches (76.2 mm) between ducts and exterior envelope wall, 2 inches (50.8 mm) between ducts for like services, and 4 inches (101.6 mm) (between power and signal ducts).
 - 7. Depth: Install top of duct bank at least 36 inches (914.4 mm) below finished grade in areas not subject to deliberate traffic, and at least 48 inches (1219.2 mm) below finished grade in deliberate traffic paths for vehicles, unless otherwise indicated.

-
8. Stub-Ups: Use manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Extend concrete encasement throughout the length of the elbow.
 9. Stub-Ups: Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose and encase coupling with 3 inches (76.2 mm) of concrete.
 - b. Stub-Ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches (1524 mm) from edge of base. Install insulated grounding bushings on terminations at equipment.
 10. Warning Tape: Bury warning tape approximately 12 inches (304.8 mm) above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches (76.2 mm) of the centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 18 inches (457.2 mm). Space additional tapes 12 inches apart, horizontally.
- I. Direct-Buried Duct Banks:
1. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
 2. Secure separators to earth and to ducts to prevent displacement during backfill and yet permit linear duct movement due to expansion and contraction as temperature changes. Stagger spacers approximately 6 inches (152.4 mm) between tiers.
 3. Excavate trench bottom to provide firm and uniform support for duct bank. Prepare trench bottoms as specified in Division 31 Section "Earth Moving" for pipes less than 6 inches (152.4 mm) in nominal diameter.
 4. Install backfill as specified in Division 31 Section "Earth Moving."
 5. After installing first tier of ducts, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand-place backfill to 4 inches (101.6 mm) over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction as specified in Division 31 Section "Earth Moving."
 6. Install ducts with a minimum of 3 inches (76.2 mm) between ducts for like services and 6 inches (152.4 mm) between power and signal ducts.
 7. Depth: Install top of duct bank at least 36 inches (914.4 mm) below finished grade, unless otherwise indicated.
 8. Set elevation of bottom of duct bank below the frost line.
 9. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of the elbow.
 10. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (76.2 mm) of concrete.
 - b. For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches (1524 mm) from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.
 11. Warning Planks: Bury warning planks approximately 12 inches (304.8 mm) above direct-buried ducts and duct banks, placing them 24 inches (609.6 mm) o.c. Align planks along the width and along the centerline of duct bank. Provide an additional plank for each 12-

inch increment of duct-bank width over a nominal 18 inches (457.2 mm). Space additional planks 12 inches apart, horizontally.

- J. Inspection: Prior to or during inspection by Authority Having Jurisdiction for approval and prior to beginning concrete pour, Engineer shall inspect underground duct installation for Engineer approval.

5.05 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

- A. Precast Concrete Handhole and Manhole Installation:
 - 1. Comply with ASTM C891, unless otherwise indicated.
 - 2. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
 - 3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- B. Elevations:
 - 1. Manhole Roof: Install with rooftop at least 15 inches (381 mm) below finished grade.
 - 2. Manhole Frame: In paved areas and traffic ways, set frames flush with finished grade. Set other manhole frames 1 inch (25.4 mm) above finished grade.
 - 3. Handhole Covers: In paved areas and traffic ways, set surface flush with finished grade. Set covers of other handholes 1 inch (25.4 mm) above finished grade.
 - 4. Where indicated, cast handhole cover frame integrally with handhole structure.
- C. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.
- D. Manhole Access: Circular opening in manhole roof; sized to match cover size.
 - 1. Install chimney, constructed of precast concrete collars and rings to support frame and cover and to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for cast-iron frame to chimney.
- E. Waterproofing: Apply waterproofing to exterior surfaces of manholes after concrete has cured at least three days. Waterproofing materials and installation are specified in Division 07 Section "Elastomeric Sheet Waterproofing." After ducts have been connected and grouted, and before backfilling, waterproof joints and connections and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at least three days.
- F. Damp proofing: Apply damp proofing to exterior surfaces of manholes after concrete has cured at least three days. Damp proofing materials and installation are specified in Division 07 Section "Bituminous Damp proofing." After ducts have been connected and grouted, and before backfilling, damp proof joints and connections and touch up abrasions and scars. Damp proof exterior of manhole chimneys after mortar has cured at least three days.
- G. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms, and insulators, as required for installation and support of cables and conductors and as indicated.
- H. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches (98 mm) for manholes and 2 inches (50.8 mm) for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.
- I. Warning Sign: Install "Confined Space Hazard" warning sign on the inside surface of each manhole cover.

5.06 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances. Use box

extension if required to match depths of ducts, and seal joint between box and extension as recommended by the manufacturer.

- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas and traffic ways, set so cover surface will be flush with finished grade. Set covers of other handholes 1 inch (25.4 mm) above finished grade.
- D. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.
- E. Field-cut openings for ducts and conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.
- F. For enclosures installed in asphalt paving and subject to occasional, non-deliberate, heavy-vehicle loading, form and pour a concrete ring encircling, and in contact with, enclosure and with top surface screeded to top of box cover frame. Bottom of ring shall rest on compacted earth.
 - 1. Concrete: 3000 psi (20684.28 kPa), 28-day strength, complying with Division 03 Section "Cast-in-Place Concrete," with a troweled finish.
 - 2. Dimensions: 10 inches (254 mm) wide by 12 inches (304.8 mm) deep.

5.07 GROUNDING

- A. Ground underground ducts and utility structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."

5.08 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections and prepare test reports:
 - 1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.
 - 2. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.
 - 3. Test manhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Division 26 Section "Grounding and Bonding for Electrical Systems."
- B. Correct deficiencies and retest as specified above to demonstrate compliance.

5.09 TRENCHES:

- A. Trenches shall be in as straight and direct a line as possible. Routes through unstable soil such as mud, shifting soils, or other hazards should be avoided. Underground conduit systems shall not be installed within 5 feet (152.4 cm) of any building foundation, swimming pool, etc., except for where service conduit merges to intercept the service equipment.

5.10 PVC INSTALLATION:

- A. The ends of the conduit shall be plugged during construction to prevent the entrance of foreign matter.
- B. All ends, joints and internal finish of the conduit shall be free of sharp edges or burrs which could damage the cable.
- C. All buried joints shall be glued with cement as recommended by the conduit manufacturers.

- D. Any change in direction between lengths of straight rigid conduit greater than 5 degrees shall be made in electrical sweeps, or with a very gradual sweeping change of direction. Any single run of conduit will contain no more than two 90 degree sweeps. If the secondary runs of conduit are less than 150 feet (4572 cm) in length then schedule 80, PVC sweeps are acceptable. For runs of conductor sized 500MCM and larger that exceed 150 feet in length, all sweeps shall be steel. For runs of conductor smaller than 500MCM size and that exceed 200 feet (6096 cm) in length, all 90° sweeps shall be steel.

5.11 CLEANING

- A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.
- B. Clean internal surfaces of manholes, including sump. Remove foreign material.

END OF SECTION

PART 1 GENERAL

1.01 REFERENCE STANDARDS

- A. 29 CFR 1910 - Occupational Safety and Health Standards; Current Edition.
- B. 29 CFR 1910.145 - Accident Prevention Signs and Tags; Current Edition.
- C. 29 CFR 1926 - Safety and Health Regulations for Construction; Current Edition.
- D. ANSI Z535.4 - American National Standard for Product Safety Signs and Labels; 2023.
- E. ASTM D638 - Standard Test Method for Tensile Properties of Plastics; 2022.
- F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- G. UL 94 - Tests for Flammability of Plastic Materials for Parts in Devices and Appliances; Current Edition, Including All Revisions.
- H. UL 510 - Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape; Current Edition, Including All Revisions.
- I. UL 969 - Marking and Labeling Systems; Current Edition, Including All Revisions.

1.02 RELATED DOCUMENTS

DRAWINGS AND GENERAL PROVISIONS OF THE CONTRACT, INCLUDING GENERAL AND SUPPLEMENTARY CONDITIONS AND DIVISION 01 SPECIFICATION SECTIONS, APPLY TO THIS SECTION.

SUMMARY

- A. Section Includes:

IDENTIFICATION FOR RACEWAYS.

IDENTIFICATION OF POWER AND CONTROL CABLES.

IDENTIFICATION FOR CONDUCTORS.

UNDERGROUND-LINE WARNING TAPE.

WARNING LABELS AND SIGNS.

INSTRUCTION SIGNS.

EQUIPMENT IDENTIFICATION LABELS.

MISCELLANEOUS IDENTIFICATION PRODUCTS.

IDENTIFICATION OF BOXES, JUNCTION BOXES AND PULL BOXES

IDENTIFICATION OF SWITCHBOARDS, MOTOR CONTROL CENTER, PANELBOARD, TRANSFORMERS, DISCONNECTING MEANS, TIMER AND ETC.

SUBMITTALS

- A. Product Data: For each electrical identification product indicated.
- B. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions riveted to the metal surface, and graphic features of identification products.
- C. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

QUALITY ASSURANCE

- A. Comply with ANSI A13.1.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

COORDINATION

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.
- B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- C. Coordinate installation of identifying devices with location of access panels and doors.
- D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 PRODUCTS

17.01 POWER RACEWAY IDENTIFICATION MATERIALS

COMPLY WITH ANSI A13.1 FOR MINIMUM SIZE OF LETTERS FOR LEGEND AND FOR MINIMUM LENGTH OF COLOR FIELD FOR EACH RACEWAY SIZE.

COLORS FOR RACEWAYS CARRYING CIRCUITS AT 600 V OR LESS:

BLACK LETTERS ON AN ORANGE FIELD.

LEGEND: INDICATE VOLTAGE AND SYSTEM OR SERVICE TYPE.

COLORS FOR RACEWAYS CARRYING CIRCUITS AT MORE THAN 600 V:

BLACK LETTERS ON AN ORANGE FIELD.

LEGEND: "DANGER CONCEALED HIGH VOLTAGE WIRING" WITH 3-INCH- HIGH LETTERS ON 20-INCH CENTERS.

SELF-ADHESIVE VINYL LABELS FOR RACEWAYS CARRYING CIRCUITS AT 600 V OR LESS: PREPRINTED, FLEXIBLE LABEL LAMINATED WITH A CLEAR, WEATHER- AND CHEMICAL-RESISTANT COATING AND MATCHING WRAPAROUND ADHESIVE TAPE FOR SECURING ENDS OF LEGEND LABEL.

SNAP-AROUND LABELS FOR RACEWAYS CARRYING CIRCUITS AT 600 V OR LESS: SLIT, PRE-TENSIONED, FLEXIBLE, PREPRINTED, COLOR-CODED ACRYLIC SLEEVE, WITH DIAMETER SIZED TO SUIT DIAMETER OF RACEWAY OR CABLE IT IDENTIFIES AND TO STAY IN PLACE BY GRIPPING ACTION.

SNAP-AROUND, COLOR-CODING BANDS FOR RACEWAYS CARRYING CIRCUITS AT 600 V OR LESS: SLIT, PRE-TENSIONED, FLEXIBLE, SOLID-COLORED ACRYLIC SLEEVE, 2 INCHES (50.8 MM) LONG, WITH DIAMETER SIZED TO SUIT DIAMETER OF RACEWAY OR CABLE IT IDENTIFIES AND TO STAY IN PLACE BY GRIPPING ACTION.

TAPE AND STENCIL FOR RACEWAYS CARRYING CIRCUITS MORE THAN 600 V: 4-INCH-WIDE BLACK STRIPES ON 10-INCH CENTERS DIAGONALLY OVER ORANGE BACKGROUND THAT EXTENDS FULL LENGTH OF RACEWAY OR DUCT AND IS 12 INCHES (304.8 MM) WIDE. STOP STRIPES AT LEGENDS.

METAL TAGS: BRASS OR ALUMINUM, 2 BY 2 BY 0.05 INCH (1.27 MM), WITH STAMPED LEGEND, PUNCHED FOR USE WITH SELF-LOCKING CABLE TIE FASTENER.

WRITE-ON TAGS: POLYESTER TAG, 0.010 INCH (0.25 MM) THICK, WITH CORROSION-RESISTANT GROMMET AND CABLE TIE FOR ATTACHMENT TO CONDUCTOR OR CABLE.

MARKER FOR TAGS: PERMANENT, WATERPROOF, BLACK INK MARKER RECOMMENDED BY TAG MANUFACTURER.

MARKER FOR TAGS: MACHINE-PRINTED, PERMANENT, WATERPROOF, BLACK INK MARKER RECOMMENDED BY PRINTER MANUFACTURER.

ARMORED AND METAL-CLAD CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

- B. Colors for Raceways Carrying Circuits at 600 V and Less:

BLACK LETTERS ON AN ORANGE FIELD.

LEGEND: INDICATE VOLTAGE AND SYSTEM OR SERVICE TYPE.

- A. Colors for Raceways Carrying Circuits at More Than 600 V:

BLACK LETTERS ON AN ORANGE FIELD.

LEGEND: "DANGER CONCEALED HIGH VOLTAGE WIRING" WITH 3-INCH- HIGH LETTERS ON 20-INCH CENTERS.

- A. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- B. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches (50.8 mm) wide; compounded for outdoor use.

POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
- B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- C. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch (1.27 mm), with stamped legend, punched for use with self-locking cable tie fastener.
- D. Write-On Tags: Polyester tag, 0.010-inch-thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.

MARKER FOR TAGS: PERMANENT, WATERPROOF, BLACK INK MARKER RECOMMENDED BY TAG MANUFACTURER.

MARKER FOR TAGS: MACHINE-PRINTED, PERMANENT, WATERPROOF, BLACK INK MARKER RECOMMENDED BY PRINTER MANUFACTURER.

- A. Snap-Around Labels: Slit, pre-tensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- B. Snap-Around, Color-Coding Bands: Slit, pre-tensioned, flexible, solid-colored acrylic sleeve, 2 inches (50.8 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

CONDUCTOR IDENTIFICATION MATERIALS

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.0762 mm) thick by 1 to 2 inches (50.8 mm) wide.
- B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- C. Snap-Around Labels: Slit, pre-tensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- D. Snap-Around, Color-Coding Bands: Slit, pre-tensioned, flexible, solid-colored acrylic sleeve, 2 inches (50.8 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- E. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
- F. Write-On Tags: Polyester tag, 0.010-inch-thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.

MARKER FOR TAGS: PERMANENT, WATERPROOF, BLACK INK MARKER RECOMMENDED BY TAG MANUFACTURER.

MARKER FOR TAGS: MACHINE-PRINTED, PERMANENT, WATERPROOF, BLACK INK MARKER RECOMMENDED BY PRINTER MANUFACTURER.

- A. All conductors shall have the color of insulation for the entire length. Do not use electrical tape to identify the colors. This applies in all sizes.

FLOOR MARKING TAPE

- A. 2-inch- wide, 5-mil pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

UNDERGROUND-LINE WARNING TAPE

- A. Tape:

RECOMMENDED BY MANUFACTURER FOR THE METHOD OF INSTALLATION AND SUITABLE TO IDENTIFY AND LOCATE UNDERGROUND ELECTRICAL AND COMMUNICATIONS UTILITY LINES.

PRINTING ON TAPE SHALL BE PERMANENT AND SHALL NOT BE DAMAGED BY BURIAL OPERATIONS.

TAPE MATERIAL AND INK SHALL BE CHEMICALLY INERT, AND NOT SUBJECT TO DEGRADING WHEN EXPOSED TO ACIDS, ALKALIS, AND OTHER DESTRUCTIVE SUBSTANCES COMMONLY FOUND IN SOILS.

- A. Color and Printing:

COMPLY WITH ANSI Z535.1 THROUGH ANSI Z535.5.

INSCRIPTIONS FOR RED-COLORED TAPES: ELECTRIC LINE, HIGH VOLTAGE.

INSCRIPTIONS FOR ORANGE-COLORED TAPES: TELEPHONE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.

WARNING LABELS AND SIGNS

- A. Comply with NFPA 70 and 29 CFR 1910.145.
- B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.
- C. Baked-Enamel Warning Signs:

PREPRINTED ALUMINUM SIGNS, PUNCHED OR DRILLED FOR FASTENERS, WITH COLORS, LEGEND, AND SIZE REQUIRED FOR APPLICATION.

1/4-INCH GROMMETS IN CORNERS FOR MOUNTING.

NOMINAL SIZE, 7 BY 10 INCHES (254 MM).

- A. Warning label and sign shall include, but are not limited to, the following legends:
- B. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
 - 1. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

EQUIPMENT IDENTIFICATION LABELS

- A. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (9.52 mm). No adhesive is strictly prohibited.
- B. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (9.52 mm). Overlay shall provide a weatherproof and UV-resistant seal for label. No adhesive is strictly prohibited.

- C. Punch or drilled riveted Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch (9.52 mm). No adhesive is strictly prohibited.
- D. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch (9.52 mm). No adhesive is strictly prohibited.
- E. Stenciled Legend: In non-fading, waterproof, black ink or paint. Minimum letter height shall be 1 inch (25.4 mm).
- F. Only use drilled/punched riveted label on equipment.

CABLE TIES

- A. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, Type 6/6 nylon.

MINIMUM WIDTH: 3/16 INCH (4.76 MM).

TENSILE STRENGTH AT 73 DEG F, ACCORDING TO ASTM D638: 12,000 PSI (82737.12 KPA).

TEMPERATURE RANGE: MINUS 40 TO PLUS 185 DEG F.

COLOR: BLACK EXCEPT WHERE USED FOR COLOR-CODING.

- A. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, Type 6/6 nylon.

MINIMUM WIDTH: 3/16 INCH (4.76 MM).

TENSILE STRENGTH AT 73 DEG F, ACCORDING TO ASTM D638: 12,000 PSI (82737.12 KPA).

TEMPERATURE RANGE: MINUS 40 TO PLUS 185 DEG F.

COLOR: BLACK.

- A. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one-piece, self-locking.

MINIMUM WIDTH: 3/16 INCH (4.76 MM).

TENSILE STRENGTH AT 73 DEG F, ACCORDING TO ASTM D638: 7000 PSI (48263.32 KPA).

UL 94 FLAME RATING: 94V-0.

TEMPERATURE RANGE: MINUS 50 TO PLUS 284 DEG F.

COLOR: BLACK.

MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in Division 09 painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 EXECUTION

72.01 INSTALLATION

VERIFY IDENTITY OF EACH ITEM BEFORE INSTALLING IDENTIFICATION PRODUCTS.

LOCATION: INSTALL IDENTIFICATION MATERIALS AND DEVICES AT LOCATIONS FOR MOST CONVENIENT VIEWING WITHOUT INTERFERENCE WITH OPERATION AND MAINTENANCE OF EQUIPMENT.

APPLY IDENTIFICATION DEVICES TO SURFACES THAT REQUIRE FINISH AFTER COMPLETING FINISH WORK.

SELF-ADHESIVE IDENTIFICATION PRODUCTS: CLEAN SURFACES BEFORE APPLICATION, USING MATERIALS AND METHODS RECOMMENDED BY MANUFACTURER OF IDENTIFICATION DEVICE.

ATTACH SIGNS AND PLASTIC LABELS THAT ARE NOT SELF-ADHESIVE TYPE WITH MECHANICAL FASTENERS APPROPRIATE TO THE LOCATION AND SUBSTRATE.

SYSTEM IDENTIFICATION COLOR-CODING BANDS FOR RACEWAYS AND CABLES: EACH COLOR-CODING BAND SHALL COMPLETELY ENCIRCLE CABLE OR CONDUIT. PLACE ADJACENT BANDS OF TWO-COLOR MARKINGS IN CONTACT, SIDE BY SIDE. LOCATE BANDS AT CHANGES IN DIRECTION, AT PENETRATIONS OF WALLS AND FLOORS, AT 50-FOOT MAXIMUM INTERVALS IN STRAIGHT RUNS, AND AT 25-FOOT MAXIMUM INTERVALS IN CONGESTED AREAS.

ALUMINUM WRAPAROUND MARKER LABELS AND METAL TAGS: SECURE TIGHT TO SURFACE OF CONDUCTOR OR CABLE AT A LOCATION WITH HIGH VISIBILITY AND ACCESSIBILITY.

CABLE TIES: FOR ATTACHING TAGS. USE GENERAL-PURPOSE TYPE, EXCEPT AS LISTED BELOW:

OUTDOORS: UV-STABILIZED NYLON.

IN SPACES HANDLING ENVIRONMENTAL AIR: PLENUM RATED.

UNDERGROUND-LINE WARNING TAPE: DURING BACKFILLING OF TRENCHES INSTALL CONTINUOUS UNDERGROUND-LINE WARNING TAPE DIRECTLY ABOVE LINE AT 6 TO 8 INCHES (203.2 MM) (BELOW FINISHED GRADE. USE MULTIPLE TAPES WHERE WIDTH OF MULTIPLE LINES INSTALLED IN A COMMON TRENCH EXCEEDS 16 INCHES (406.4 MM) OVERALL.

PAINTED IDENTIFICATION: COMPLY WITH REQUIREMENTS IN DIVISION 09 PAINTING SECTIONS FOR SURFACE PREPARATION AND PAINT APPLICATION.

IDENTIFICATION SCHEDULE

A. Identification of Electrical Systems

IDENTIFY ALL EQUIPMENT AND CIRCUIT BREAKERS.

IDENTIFY ALL J-BOX COVERS WITH CIRCUIT NUMBERS.

ON ALL DEVICE WALL PLATES, ON INSIDE OF PLATE, INDICATE PANEL AND CIRCUIT NUMBER FEEDING THE DEVICE.

ALL ELECTRICAL PANELS SHALL HAVE TYPE WRITTEN PANEL SCHEDULE WITH ROOM DESCRIPTIONS USING ACTUAL ROOM SIGNAGE NUMBERS.

ELECTRICAL SYSTEMS SHALL BE IDENTIFIED BY PAINTED JUNCTION BOXES AND COVERS WITH THE FOLLOWING SCHEME:

1. Lighting system: Yellow
2. Emergency Power: Red
3. 120V Power: Blue
4. HVAC system power: Green

ELECTRICAL PANEL IDENTIFICATION SHALL INCLUDE THE FOLLOWING:

1. Panel Name
2. Voltage
3. Amperage
4. General description such as: Lighting Area A or Power Area C. Refer to Drawings.
5. Appropriately colored for emergency.
6. Feeder panel designation must be clearly identified.

ACCESSIBLE RACEWAYS AND METAL-CLAD CABLES, 600 V OR LESS, FOR SERVICE, FEEDER, AND BRANCH CIRCUITS MORE THAN 30 A, AND 120 V TO GROUND: IDENTIFY WITH SELF-ADHESIVE VINYL LABEL. INSTALL LABELS AT 10-FOOT MAXIMUM INTERVALS.

ACCESSIBLE RACEWAYS AND CABLES WITHIN BUILDINGS: IDENTIFY THE COVERS OF EACH JUNCTION AND PULL BOX OF THE FOLLOWING SYSTEMS WITH SELF-ADHESIVE VINYL LABELS WITH THE WIRING SYSTEM LEGEND AND SYSTEM VOLTAGE. SYSTEM LEGENDS SHALL BE AS FOLLOWS:

EMERGENCY POWER.

POWER.

- A. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and hand-holes, use color-coding conductor tape to identify the phase.

COLOR-CODING FOR PHASE AND VOLTAGE LEVEL IDENTIFICATION, 600 V OR LESS: USE COLORS LISTED BELOW FOR UNGROUNDED SERVICE, FEEDER, AND BRANCH-CIRCUIT CONDUCTORS.

1. New Conductors: Insulation shall be fully and continuously colored. Phase taping is not acceptable.
2. Existing Conductors Re-terminated: Use Scotch #35 Vinyl Electrical Color-Coding Tape. No substitutions. Material to be 7-mil polyvinyl chloride (PVC), 3/4"-wide tape with UL 510 rating to 600 VAC. Field apply two full laps without offset at each start and finish, and with 3/8"-over-lap for all intermediate laps using 5 lb/in tension. Start tape no further than 1-1/4" from termination and provide minimum cover length of:
 - a. #2 AWG and smaller conductors: 6 inches (152.4 mm).
 - b. #1/0 AWG and larger conductors: 8 inches (203.2 mm).
3. Colors for 208/120-V Circuits:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue.
 - d. Neutral: White
 - e. Ground: Green
4. Colors for 480/277-V Circuits:
 - a. Phase A: Brown.
 - b. Phase B: Purple
 - c. Phase C: Yellow.
 - d. Neutral: Gray/White
 - e. Ground: Green

INSTALL INSTRUCTIONAL SIGN INCLUDING THE COLOR CODE FOR GROUNDED AND UNGROUNDED CONDUCTORS USING ADHESIVE-FILM-TYPE LABELS.

CONDUCTORS TO BE EXTENDED IN THE FUTURE: ATTACH MARKER TAPE TO CONDUCTORS AND LIST SOURCE.

AUXILIARY ELECTRICAL SYSTEMS CONDUCTOR IDENTIFICATION: IDENTIFY FIELD-INSTALLED ALARM, CONTROL, AND SIGNAL CONNECTIONS.

IDENTIFY CONDUCTORS, CABLES, AND TERMINALS IN ENCLOSURES AND AT JUNCTIONS, TERMINALS, AND PULL POINTS. IDENTIFY BY SYSTEM AND CIRCUIT DESIGNATION.

USE SYSTEM OF MARKER TAPE DESIGNATIONS THAT IS UNIFORM AND CONSISTENT WITH SYSTEM USED BY MANUFACTURER FOR FACTORY-INSTALLED CONNECTIONS.

COORDINATE IDENTIFICATION WITH PROJECT DRAWINGS, MANUFACTURER'S WIRING DIAGRAMS, AND THE OPERATION AND MAINTENANCE MANUAL.

LOCATIONS OF UNDERGROUND LINES: IDENTIFY WITH UNDERGROUND-LINE WARNING TAPE FOR POWER, LIGHTING, COMMUNICATION, AND CONTROL WIRING AND OPTICAL FIBER CABLE.

LIMIT USE OF UNDERGROUND-LINE WARNING TAPE TO DIRECT-BURIED CABLES.

INSTALL UNDERGROUND-LINE WARNING TAPE FOR BOTH DIRECT-BURIED CABLES AND CABLES IN RACEWAY.

WORKSPACE INDICATION: INSTALL FLOOR MARKING TAPE TO SHOW WORKING CLEARANCES IN THE DIRECTION OF ACCESS TO LIVE PARTS. WORKSPACE SHALL BE AS REQUIRED BY NFPA 70 AND 29 CFR 1926.403 UNLESS OTHERWISE INDICATED. DO NOT INSTALL AT FLUSH-MOUNTED PANELBOARDS AND SIMILAR EQUIPMENT IN FINISHED SPACES.

WARNING LABELS FOR INDOOR CABINETS, BOXES, AND ENCLOSURES FOR POWER AND LIGHTING: SELF-ADHESIVE WARNING LABELS.

COMPLY WITH 29 CFR 1910.145.

IDENTIFY SYSTEM VOLTAGE WITH BLACK LETTERS ON AN ORANGE BACKGROUND.

APPLY TO EXTERIOR OF DOOR, COVER, OR OTHER ACCESS.

FOR EQUIPMENT WITH MULTIPLE POWER OR CONTROL SOURCES, APPLY TO DOOR OR COVER OF EQUIPMENT INCLUDING, BUT NOT LIMITED TO, THE FOLLOWING:

1. Power transfer switches.
2. Controls with external control power connections.

OPERATING INSTRUCTION SIGNS: INSTALL INSTRUCTION SIGNS TO FACILITATE PROPER OPERATION AND MAINTENANCE OF ELECTRICAL SYSTEMS AND ITEMS TO WHICH THEY CONNECT. INSTALL INSTRUCTION SIGNS WITH APPROVED LEGEND WHERE INSTRUCTIONS ARE NEEDED FOR SYSTEM OR EQUIPMENT OPERATION.

EMERGENCY OPERATING INSTRUCTION SIGNS: INSTALL INSTRUCTION SIGNS WITH WHITE LEGEND ON A RED BACKGROUND WITH MINIMUM 3/8-INCH- HIGH LETTERS FOR EMERGENCY INSTRUCTIONS AT EQUIPMENT USED FOR POWER TRANSFER.

EQUIPMENT IDENTIFICATION LABELS: ON EACH UNIT OF EQUIPMENT, INSTALL UNIQUE DESIGNATION LABEL THAT IS CONSISTENT WITH WIRING DIAGRAMS, SCHEDULES, AND THE OPERATION AND MAINTENANCE MANUAL. APPLY LABELS TO DISCONNECT SWITCHES AND PROTECTION EQUIPMENT, CENTRAL OR MASTER UNITS, CONTROL PANELS, CONTROL STATIONS, TERMINAL CABINETS, AND RACKS OF EACH SYSTEM. SYSTEMS INCLUDE POWER, LIGHTING, CONTROL, COMMUNICATION, SIGNAL, MONITORING, AND ALARM SYSTEMS UNLESS EQUIPMENT IS PROVIDED WITH ITS OWN IDENTIFICATION.

LABELING INSTRUCTIONS:

1. Indoor Equipment: Self-adhesive, engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch-high label; where two lines of text are required, use labels 2 inches (50.8 mm) high.
2. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
3. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
4. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

EQUIPMENT TO BE LABELED: USE PUNCHED, DRILLED RIVETED LABEL OR IDENTIFICATIONS

1. Panelboards: Typewritten hard thick card stock paper directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be laminated acrylic or melamine label.
2. Enclosures and electrical cabinets.
3. Access doors and panels for concealed electrical items.
4. Switchboards.
5. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
6. Substations.
7. Emergency system boxes and enclosures.
8. Motor-control centers.
9. Enclosed switches.
10. Enclosed circuit breakers.
11. Enclosed controllers.
12. Variable-speed controllers.
13. Push-button stations.
14. Power transfer equipment.
15. Contactors.
16. Remote-controlled switches, dimmer modules, and control devices.
17. Battery-inverter units.
18. Battery racks.
19. Power-generating units.
20. Monitoring and control equipment.

END OF SECTION

26 05 73

OVERCURRENT PROTECTIVE DEVICE COORDINATION AND ARC FLASH STUDY

PART 1 GENERAL

3.01 REFERENCE STANDARDS

- A. ICEA P-45-482 - Short Circuit Performance of Metallic Shields and Sheaths on Insulated Cables; 2023.
- B. IEEE 141 - IEEE Recommended Practice for Electric Power Distribution for Industrial Plants; 1993 (Reaffirmed 1999).
- C. IEEE 241 - IEEE Recommended Practice for Electric Power Systems in Commercial Buildings; 1990 (Reaffirmed 1997).
- D. IEEE 242 - IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems; 2001, with Errata (2003).
- E. IEEE 399 - IEEE Recommended Practice for Industrial and Commercial Power Systems Analysis; 1997.
- F. IEEE 1584 - IEEE Guide for Performing Arc-Flash Hazard Calculations; 2018, with Errata (2019).
- G. IEEE C37.20.1 - IEEE Standard for Metal-Enclosed Low-Voltage (1000 Vac and Below, 3200 Vdc and Below) Power Circuit Breaker Switchgear; 2015, with Amendment (2020).
- H. IEEE C57.12.00 - IEEE Standard for General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers; 2021.
- I. IEEE C57.96 - IEEE Standard Guide for Loading Dry-Type Distribution and Power Transformers; 2013.
- J. NFPA 70E - Standard for Electrical Safety in the Workplace; 2024.

3.02 RELATED DOCUMENTS

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

3.03 SUMMARY

- A. This Section includes computer-based, fault-current, overcurrent protective device coordination selective studies, and arc flash study. Protective devices shall be set based on results of the protective device coordination selective study.
 - 1. Coordination of series-rated devices is permitted where indicated on Drawings.
 - 2. Retain a qualified professional/engineering firm to assist in the development and implementation of the arc flash and protection coordination selective study.

3.04 SUBMITTALS

- A. Product Data: For computer software program to be used for studies.
- B. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.
- C. Qualification Data: For coordination-selective study specialist.
- D. Other Action Submittals: The following submittals shall be made after the approval process for system protective devices has been completed. Submittals may be in digital form.
 - 1. Coordination- selective study input data, including completed computer program input data sheets.
 - 2. Study and Equipment Evaluation Reports.

3. Coordination- Selective Study Report.
4. Electrical One-line diagram

3.05 QUALITY ASSURANCE

- A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.
- B. Coordination- Selective Study Specialist Qualifications: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
 1. Professional engineer, licensed in the state where Project is located, shall be responsible for the study.
- C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.
- D. Comply with IEEE 399 for general study procedures.
- E. The entity shall have an employee that is certified, train and skilled to perform this type of test and be able to interpret the curve and settings.

PART 2 PRODUCTS

4.01 COMPUTER SOFTWARE DEVELOPERS

- A. Available Computer Software Developers: Subject to compliance with requirements, companies offering computer software programs that may be used in the Work include, but are not limited to, the following:
- B. Computer Software Developers: Subject to compliance with requirements, provide products by one of the following:
- C. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 1. CGI CYME.
 2. EDSA Micro Corporation.
 3. ESA Inc.
 4. Operation Technology, Inc.
 5. SKM Systems Analysis, Inc.

4.02 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

- A. Comply with IEEE 399.
- B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.

PART 3 EXECUTION

5.01 EXAMINATION

- A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.
 1. Proceed with coordination selective study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

5.02 POWER SYSTEM DATA

- A. Gather and tabulate the following input data to support coordination study:
1. Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
 2. Impedance of utility service entrance.
 3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:
 - a. Circuit-breaker and fuse-current ratings and types.
 - b. Relays and associated power and current transformer ratings and ratios.
 - c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
 - d. Generator kilovolt amperes, size, voltage, and source impedance.
 - e. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
 - f. Busway ampacity and impedance.
 - g. Motor horsepower and code letter designation according to NEMA MG 1.
 4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:
 - a. Special load considerations, including starting inrush currents and frequent starting and stopping.
 - b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
 - c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
 - d. Generator thermal-damage curve.
 - e. Ratings, types, and settings of utility company's overcurrent protective devices.
 - f. Special overcurrent protective device settings or types stipulated by utility company.
 - g. Time-current-characteristic curves of devices indicated to be coordinated.
 - h. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
 - i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
 - j. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.

5.03 FAULT-CURRENT STUDY

- A. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:
1. Switchgear and switchboard bus.
 2. Medium-voltage controller.
 3. Motor-control center.
 4. Distribution panelboard.
 5. Branch circuit panelboard.

- B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.
- C. Calculate momentary and interrupting duties on the basis of maximum available fault current.
- D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 141, IEEE 241 and IEEE 242.
 - 1. Transformers:
 - a. ANSI C57.12.10.
 - b. ANSI C57.12.22.
 - c. ANSI C57.12.40.
 - d. IEEE C57.12.00.
 - e. IEEE C57.96.
 - 2. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1.
 - 3. Low-Voltage Fuses: IEEE C37.46.
- E. Study Report:
 - 1. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.
 - 2. Show interrupting (5-cycle) and time-delayed currents (6 cycles and above) on medium and high voltage breakers as needed to set relays and assess the sensitivity of overcurrent relays.
- F. Equipment Evaluation Report:
 - 1. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
 - 2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
 - 3. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

5.04 COORDINATION SELECTIVE STUDY

- A. Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.
 - 1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.
 - 2. Calculate the maximum and minimum interrupting duty (5 cycles to 2 seconds) short-circuit currents.
 - 3. Calculate the maximum and minimum ground-fault currents.
- B. Comply with IEEE 141 recommendations for fault currents and time intervals.
- C. Transformer Primary Overcurrent Protective Devices:
 - 1. Device shall not operate in response to the following:
 - a. Inrush current when first energized.
 - b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
 - c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
 - 2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.
- D. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that

equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

- E. Coordination-Selective Study Report: Prepare a written report indicating the following results of coordination study:
1. Tabular Format of Settings Selected for Overcurrent Protective Devices:
 - a. Device tag.
 - b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
 - c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
 - d. Fuse-current rating and type.
 - e. Ground-fault relay-pickup and time-delay settings.
 2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:
 - a. Device tag.
 - b. Voltage and current ratio for curves.
 - c. Three-phase and single-phase damage points for each transformer.
 - d. No damage, melting, and clearing curves for fuses.
 - e. Cable damage curves.
 - f. Transformer inrush points.
 - g. Maximum fault-current cutoff point.
- F. Completed data sheets for setting of overcurrent protective devices.

5.05 ARC FLASH STUDY

- A. A detailed arc flash study shall be performed to determine potential arc flash incident energies, arc flash boundaries, shock hazard boundaries and proper personal protective equipment (PPE) for all energized electrical system equipment tasks for the electrical systems studied. The calculations shall comply with NFPA 70E 2009, and IEEE 1584. Bolted short circuit calculations used in the above standards shall comply with ANSI C37.010, C37.13, C37.5, IEEE 141, and IEEE 399. The purpose of this study is to determine arc flash hazards in conformance with NFPA 70E and to provide a comprehensive software model of the electrical distribution system, which provides integral work permits and arc flash calculations in compliance with NFPA 70E Articles 130.1 and 130.3 for all equipment in the facility. The software program used in this study shall comply with the above standards. No substitutions in calculation methods will be allowed.
- B. The arc flash study shall determine the following results for each system mode of operation developed in Section 1.3E (Modeling). The results shall be provided in spreadsheet format for each mode and electrical system location to provide easy viewing and comparison. Worst-case arc flash energy levels shall be flagged and the spreadsheet comparison table shall be capable of providing its output directly to high quality vinyl label printers. The calculations shall, as a minimum, include a comparison of both 100% and 85% arcing currents for low voltage equipment for each electrical system configuration or operating mode, indicating worst-case arc flash hazards. The spreadsheet results shall include:
1. Equipment name and voltage
 2. Upstream equipment device name and ANSI function, i.e. 51/50, etc.
 3. Equipment type, i.e. switchgear, MCC, Panel, VFD, etc.
 4. Equipment arc gap

5. Bolted and estimated arcing fault current at the fault point (equipment) in symmetrical amperes. The estimated arcing current should be based on the arcing current equations used.
 6. Trip time, opening time, and total clearing time (total Arc time) of the protective device
 7. Worst-case arc flash boundary for each bus/equipment in the model
 8. Worst-case arc flash hazard incident energy in cal/cm² for each bus/equipment in the model
 9. Worst-case personal protective equipment (PPE) for each bus/equipment in the model
 10. Working distances for up to five different distances showing items 7, 8, and 9 for each distance
 11. Indicate "Danger/Hazardous" areas where incident energy is greater than 40 cal/cm² and provide recommendations to reduced arc flash energy levels for these areas
 12. Flag results where 85% arcing current provided worst-case results
 13. Each mode of operation shall include a detailed write-up indicating areas where incident energy calculations and PPE requirements are higher than calculated in the normal operating mode.
- C. Contractor shall provide a detailed arc flash analysis report including as a minimum:
1. Introduction
 2. Methodology
 3. Information Sources
 4. Assumptions including generic substitutions when data cannot be field verified. This type of assumptions shall be documented in the report.
 5. Arc Flash Energy and other consideration for various System Modes of Operation (maintenance mode, bus-tie, co-gen on/off, etc.)
 6. Arc Energy at 100% and reduced currents
 7. IEEE 1584-2002 Considerations.
 8. Overcurrent Protective Device Changes, Replacements or Setting Changes implemented in study to reduce arc flash hazard exposure.
 9. Explanation of Data in Arc Flash Hazard Report Tables
 10. NFPA 70E Information
 - a. Shock Hazards with covers removed.
 - b. Shock Hazard Approach Boundaries.
 - 1) Limited Approach Boundary
 - 2) Restricted Approach Boundary
 - 3) Prohibited Approach Boundary
 - c. Arc Flash Hazard Boundaries
 11. Results of Arc Flash Hazard Analysis for high voltage, medium voltage and low voltage systems, including:
 - a. Working distances.
 - b. Energy Levels
 - c. PPE Requirements
 - d. Recommendations to reduce arc flash hazard energy and exposure.
 12. Arc Flash Hazard Report
 13. 3 Hard Copies
 - a. 1 Electronic Copy in WORD or Excel format and PDF (5.0 or later)
 - b. 1 Electronic copy in latest version of SKM format or its native software
 14. Electronic file for Power System Modeling Software as developed and utilized for this analysis.

- D. Contractor shall provide print labels for all equipment in the system from the project study file. Assume two (2) labels per equipment/bus in your estimate using 4" x 6" labels. The labels shall be UV resistant vinyl labels (white with orange warning strip and black letters) conforming to ANSI-Z 535. The labels shall be printable directly from the power system software utilized for the study.
- E. The software shall provide complete integration of the one-line, database, short circuit and PDC and Arc flash functions. Software using separate short circuit, PDC, TCC or arc flash programs is not allowed. Spreadsheet calculations are not allowed. The purpose of this section is to ensure that the arc flash hazard calculations comply with NFPA 70E and IEEE 1584, and that the calculations are programmed with necessary requirements to help eliminate possible errors in the arc flash calculations. The additional purpose is to establish a detailed software model of the compliance with the OSHA requirements and NFPA 70E mandates.
1. Arc flash calculations shall be performed with enhanced IEEE 1584 equations, which eliminate voltage discontinuities and the non-conservative/average results of the standard equations. The purpose of this requirement is to ensure that the calculated incident energies are closer to actual test results insuring a conservative calculation minimizing personnel risk.
 2. Arc flash calculations shall be based on the fastest clearing upstream protective device protecting the equipment for single sources and the slowest upstream protective device for multiple sources. The calculations shall automatically compare all series and parallel upstream protective devices in the system to determine the fastest series device or a conservative parallel clearing time.
 3. The arc flash calculations shall include arc flash boundary, incident energy, PPE requirements, and working distances.
 4. The arc flash calculations shall include calculations for all operating modes to ensure the worse arc flash magnitude.
 5. The arc flash calculations shall provide integral "Work Tasks" for the listed equipment types. The tasks shall be derived from 70E Table 130.7(C)(9)(a) and be specific to the equipment type. Listed equipment types shall include:
 - a. Switchgear, Switchboards, Panelboards, MCC, VFD, UPS, ATS, Interrupting Switch, NEMA E2 Contactor, Conductor, Open Air for 100-200 volt equipment.
 - b. Switchgear, Switchboards, Panelboards, MCC, VFD, UPS, ATS, Interrupting Switch, NEMA E2 Contactor, Conductor, Open Air for 200-1000 volt equipment.
 - c. Switchgear, MCC, VFD, UPS, ATS, Interrupting Switch, NEMA E2 Contactor, Conductor, Open Air for 1.0-5.0 kV equipment.
 - d. Switchgear, MCC, VFD, ATS, Interrupting Switch, NEMA E2 Contactor, Conductor, Open Air for 5.0-15.0 kV equipment.
 - e. Interrupting Switch, Conductor, and Open Air for 138 kV equipment.
 6. Work Tasks shall have a user-defined library that provides the following customizable features for each work task:
 - a. Work Tasks for each specific equipment type and voltage range
 - b. Working distance units English or Metric
 - c. Work distance for each task
 - d. V-rated gloves and tool requirements
 - e. Job description and procedures
 - f. Safe work practices description
 - g. Hazard Risk Category (HRC) reduction - HRC reduction can only be used based on a documented risk assessment as an integral part of a safety program.

END OF SECTION

26 09 23

LIGHTING CONTROL DEVICES

PART 1 GENERAL

3.01 RELATED DOCUMENTS

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

3.02 SUMMARY

- A. This Section includes the following lighting control devices:
 - 1. Time switches.
 - 2. Photoelectric switches.
 - 3. Indoor occupancy sensors.
 - 4. Lighting contactors.
 - 5. Emergency shunt relays.
- B. Related Sections include the following:
 - 1. Division 26 Section "Wiring Devices" for wall-box dimmers, wall-switch occupancy sensors, and manual light switches.

3.03 DEFINITIONS

- A. LED: Light-emitting diode.
- B. PIR: Passive infrared.

3.04 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.
- B. NEMA ICS 2 - Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts; 2008 (Reaffirmed 2020).
- C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D. UL 508 - Industrial Control Equipment; Current Edition, Including All Revisions.
- E. UL 773A - Nonindustrial Photoelectric Switches for Lighting Control; Current Edition, Including All Revisions.
- F. UL 917 - Clock-Operated Switches; Current Edition, Including All Revisions.

3.05 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show installation details for occupancy and light-level sensors.
 - 1. Interconnection diagrams showing field-installed wiring.
 - 2. Provide Settings requirements available from the Owner standpoint.
 - 3. Provide the software that will support the lighting controllers.
 - 4. Software must have the ability to detect outages or no power to a branch circuit and graphic indicators.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

3.06 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

3.07 COORDINATION

- A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression system, and partition assemblies.

PART 2 PRODUCTS

4.01 TIME SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Intermatic, Inc.
 - 2. Leviton Mfg. Company Inc.
 - 3. Lightolier Controls; a Genlyte Company.
 - 4. Lithonia Lighting; Acuity Lighting Group, Inc.
 - 5. Watt Stopper (The).
- B. Electronic Time Switches: Electronic, solid-state programmable units with alphanumeric display; complying with UL 917.
- C. Electromechanical-Dial Time Switches: Type complying with UL 917.

4.02 OUTDOOR PHOTOELECTRIC SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Intermatic, Inc.
 - 2. Lithonia Lighting; Acuity Lighting Group, Inc.
 - 3. Novitas, Inc.
 - 4. TORK.
 - 5. Watt Stopper (The).

4.03 INDOOR OCCUPANCY SENSORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Hubbell Lighting.
 - 2. Leviton Mfg. Company Inc.
 - 3. Lithonia Lighting; Acuity Lighting Group, Inc.
 - 4. Watt Stopper (The).
- B. General Description: Wall- or ceiling-mounting, solid-state units with a separate relay unit.
 - 1. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 - 2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
 - 3. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
 - 4. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outlet box.
 - b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.

- c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
- 5. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.
- 6. Bypass Switch: Override the on function in case of sensor failure.
- 7. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; keep lighting off when selected lighting level is present.
- C. Dual-Technology Type: Ceiling mounting; detect occupancy by using a combination of PIR and ultrasonic detection methods in area of coverage. Particular technology or combination of technologies that controls on-off functions shall be selectable in the field by operating controls on unit.
 - 1. Sensitivity Adjustment: Separate for each sensing technology.
 - 2. Detector Sensitivity: Detect occurrences of 6-inch-minimum movement of any portion of a human body that presents a target of not less than 36 sq. in., and detect a person of average size and weight moving not less than 12 inches (304.8 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
 - 3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch-high ceiling.

4.04 OUTDOOR MOTION SENSORS (PIR)

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
 - 1. Bryant Electric; a Hubbell Company.
 - 2. Hubbell Lighting.
 - 3. Lithonia Lighting; Acuity Lighting Group, Inc.
 - 4. Watt Stopper (The).
- C. Performance Requirements: Suitable for operation in ambient temperatures ranging from minus 40 to plus 130 deg F, rated as rain-tight according to UL 773A.
 - 1. Operation: Turn lights on when sensing infrared energy changes between background and moving body in area of coverage; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 - 2. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outdoor junction box.
 - b. Relay: Internally mounted in a standard weatherproof electrical enclosure.
 - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 - 3. Bypass Switch: Override the on function in case of sensor failure.
 - 4. Automatic Light-Level Sensor: Adjustable from 1 to 20 fc; keep lighting off during daylight hours.
- D. Detector Sensitivity: Detect occurrences of 6-inch-minimum movement of any portion of a human body that presents a target of not less than 36 sq. in.
- E. Lighting Fixture Mounted Sensor: Suitable for switching 300 W of tungsten load at 120- or 277-V ac.
- F. Individually Mounted Sensor: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
 - 1. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.

2. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.

4.05 LIGHTING CONTACTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Square D
 2. ASCO Power Technologies, LP; a division of Emerson Electric Co.
 3. Eaton Electrical Inc.; Cutler-Hammer Products.
 4. GE.
 5. TORK.
- B. Description: Electrically operated and mechanically held, combination type with non-fusible switch complying with NEMA ICS 2 and UL 508.
 1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).
 2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
 3. Enclosure: Comply with NEMA 250.
 4. Provide with control and pilot devices matching the NEMA type specified for the enclosure.
- C. BAS Interface: Provide hardware interface to enable the BAS to monitor and control lighting contactors.
 1. Monitoring: On-off status.
 2. Control: On-off operation.

4.06 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- B. Classes 2 and 3 Control Cable: Multi-conductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- C. Class 1 Control Cable: Multi-conductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

PART 3 EXECUTION

5.01 SENSOR INSTALLATION

- A. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

5.02 CONTACTOR INSTALLATION

- A. Mount electrically held lighting contactors with elastomeric isolator pads, to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

5.03 WIRING INSTALLATION

- A. Wiring Method: Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size shall be 1/2 inch (12.7 mm).
- B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and non-power limited conductors according to conductor manufacturer's written instructions.

- C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.
- D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.
- E. All conductors shall be installed in an enclosed by a metal raceway.

5.04 IDENTIFICATION

- A. Identify components and power and control wiring according to Division 26 Section "Identification for Electrical Systems."
 - 1. Identify controlled circuits in lighting contactors.
 - 2. Identify circuits or luminaries controlled by photoelectric and occupancy sensors at each sensor.
- B. Label time switches and contactors with a unique designation.

5.05 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.
 - 2. Operational Test: Verify operation of each lighting control device and adjust time delays.
- B. Lighting control devices that fail tests and inspections are defective work.

5.06 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

5.07 DEMONSTRATION

- A. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control system specified in Division 26 Section "Network Lighting Controls."
- B. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Requirements of Division 26 "COMMON WORK RESULTS FOR ELECTRICAL" apply to this Section.

1.02 SECTION INCLUDES

- A. Fireproof fire stopping materials.

1.03 REFERENCE STANDARDS

- A. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems; 2024.

1.04 SUBMITTALS: SUBMIT THE FOLLOWING IN ACCORDANCE WITH SECTION 260500.

- A. Fireproof fire stopping materials.
- B. Provide U.L. category and file numbers of products.

1.05 QUALITY ASSURANCE: COMPLY WITH THE FOLLOWING.

- A. ASTM E814 (UL 1479) - Test Method of Fire Tests of Through-Penetration Fire stops.
- B. NEC 300-21 and NEC 800-52(b).
- C. Conform to applicable code for fire resistance ratings and surface burning characteristics.
- D. Provide certificate of compliance from authority having jurisdiction indicating approval of combustibility.

1.06 SEQUENCING

- A. Sequence work to permit fire stopping materials to be installed after adjacent and surrounding work is complete.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Flame-Safe FS500, FST600, FS900, FST900, or FSP1000.
- B. Dow Corning 306548 Silicone RTV Foam.
- C. 3M Fire Barrier Penetration Sealing Systems.
- D. PENSIL 851, General Electric Company.

2.02 PERFORMANCE REQUIREMENTS

- A. The requirements of this section shall be provided in addition to the requirements of Division 7.
- B. Maintain required classification, fire, acoustic, and vapor barrier ratings for electrical installations penetrating walls, ceilings, and floors per ASTM E814 (UL 1479), NEC 300-21 and NEC 800-52(b).
 - 1. Penetrations of classified area walls, ceiling and floors shall be sealed with the same material to maintain the integrity of area classification.
 - 2. Penetrations of fire-rated walls, ceilings, and floors shall be sealed with a UL listed Through-Penetrations Fire-Stop System.
 - 3. Penetrations of non-fire-rated walls, ceilings, and floors shall be filled and finished using the same finish material as the wall, ceiling, or floor.
 - 4. Outlet box and lighting fixture installation in fire-rated walls, ceilings, and floors shall be in accordance with the UL Fire Resistance Directory.
- C. Fire safety system shall not require de-rating the ampacity of electrical conductors.
- D. Where mastic is used to seal the surface of the fire stop, the mastic shall be non-hardening.

- E. Fire safety material shall not contract to allow transmission of smoke or water prior to exposure of a fire condition.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that openings are ready to receive the work of this section.

3.02 PREPARATION

- A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter which may affect bond of fire stopping material.
- B. Remove incompatible materials which affect bond.

3.03 APPLICATION

- A. Apply primer and materials in accordance with manufacturer's instructions.
- B. Apply fire stopping material in sufficient thickness to achieve rating to uniform density and texture.
- C. Install material at walls or partition openings which contain penetrating sleeves, piping, ductwork, conduit, and other items requiring fire stopping.
- D. Sleeves shall be of suitable length to accommodate fire stopping system used. Where conduit passes through a sleeve, the clearance around the conduit shall not be less than 1/2".

3.04 CLEANING

- A. Clean adjacent surfaces of fire stopping materials.

3.05 PROTECTION OF FINISHED WORK

- A. Protect adjacent surfaces from damage by material installation.

END OF SECTION

26 22 00

LOW-VOLTAGE TRANSFORMERS

PART 1 GENERAL

3.01 REFERENCE STANDARDS

- A. 10 CFR 431 - Energy Efficiency Program for Certain Commercial and Industrial Equipment - Distribution Transformers; Current Edition.
- B. IEEE 519 - IEEE Standard for Harmonic Control in Electric Power Systems; 2022.
- C. IEEE C57.12.91 - IEEE Standard Test Code for Dry-Type Distribution and Power Transformers; 2020.
- D. NEMA ST 20 - Dry Type Transformers for General Applications; 2021.
- E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. UL 1561 - Standard for Dry-Type General Purpose and Power Transformers; Current Edition, Including All Revisions.

3.02 RELATED DOCUMENTS

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

3.03 SUMMARY

- A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:
 - 1. Harmonics Mitigating (Canceling) Transformers as indicated on Drawings:
 - a. Delta-to-ZigZag 0-degree phase shift secondary.
 - b. Wye-to-ZigZag 30-degree phase shift secondary.

3.04 SUBMITTALS

- A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.
- B. Coordination Drawings: Provide coordination drawings as described in 26 05 00 paragraph 1.03(C).
- C. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
- D. Qualification Data: For testing agency.
- E. Source quality-control test reports.
- F. Field quality-control test reports.
- G. Operation and Maintenance Data.

3.05 QUALITY ASSURANCE

- A. Source Limitations: Obtain each transformer type through one source from a single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

- D. Harmonics Canceling Transformers: NEMA ST-1, TP-1, TP-2 and IEEE 519-1992 compliance.
- E. Comply with United States Department of Energy (DOE), United States Code (USC) and Code of Federal Regulations (CFR)
 - 1. 42 USC - Energy Conservation Program for Consumer Products Other Than Automobiles
 - 2. 10 CFR 431 – Energy Efficiency Program for Certain Commercial and Industrial Equipment, Subpart K – Distribution Transformers
 - 3. Appendix A to Subpart K of 10 CFR part 431 - Uniform Test Method for Measuring the Energy Consumption of Distribution Transformers

3.06 DELIVERY, STORAGE, AND HANDLING

- A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

3.07 COORDINATION

- A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

PART 2 PRODUCTS

4.01 MANUFACTURERS

- A. General Purpose Dry-Type: Subject to compliance with requirements, provide products by one of the following:
 - 1. Square D / Schneider Electric
 - 2. Siemens
 - 3. Eaton / Cutler Hammer
- B. General Purpose Dry-Type: Subject to compliance with requirements, provide products by one of the following:
 - 1. Powersmiths T1000-30H
 - 2. Power Quality International
 - 3. Mirus
 - a. GENERAL TRANSFORMER REQUIREMENTS
- C. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.
- D. Cores: Grain-oriented, non-aging silicon steel.
- E. Coils: Continuous windings without splices except for taps.
 - 1. Internal Coil Connections: Brazed or pressure type.
 - 2. Coil Material: Copper, unless indicated otherwise in Drawings.
 - 3. Core and coil designs shall be low loss type with minimum efficiencies per NEMA TP1 and 10 CFR §431.196(a)(2) (DOE 2016 requirements) when operated at 35% of full load capacity. Efficiency shall be tested in accordance with NEMA TP2 and 10 CFR §431.193.
- F. Enclosures: NEMA 2 or 3R rating as required, unless otherwise indicated on Drawings.
 - 1. Provide hinged doors with infrared scanning window.
 - 2. Provide surge protection device (SPD).
 - 3. Provide compression lug kit for all terminations.
- G. Efficiencies:

SINGLE PHASE	THREE PHASE

KVA	EFFICIENCY	KVA	EFFICIENCY
15	97.7%	15	97.89%
25	98.0%	30	98.23%
37.5	98.2%	45	98.40%
50	98.3%	75	98.60%
75	98.5%	112.5	98.74%
100	98.6%	150	98.83%
167	98.7%	225	98.94%
250	98.8%	300	99.02%
333	98.9%	500	99.14%
		750	99.23%
		1000	99.28%

4.01 HARMONIC MITIGATING TRANSFORMERS

- A. Single Output (Secondary):
 1. DZO – Delta Primary, Zig-Zag Secondary, 0° phase shift.
 2. YZ30 – Wye Primary (ungrounded neutral), Zig-Zag Secondary, 30° phase shift.
- B. Insulation and Varnish systems: 220 deg. C. Class R, Epoxy polyester impregnation, 130°C Temperature Rise in 40°C Ambient.
- C. All terminals. Including those for changing taps, must be readily accessible. Windings shall be continuous with terminations brazed or welded. 10KV BIL.
- D. Compatible with all types of linear and non-linear current and future loads.
- E. Impedance: Between 3.0% and 5.0% at rated KVA.
- F. Zero sequence Impedance/reactance less than 0.95% and 0.3% respectively.
- G. Zero sequence currents not coupled into primary windings.
- H. Voltage Taps: Two (2) 2.5% above and four (4) 2.5% below nominal primary voltage.
- I. Provide dual electrostatic shield.

4.02 DISTRIBUTION TRANSFORMERS

- A. Comply with NEMA ST 20, and list and label as complying with UL 1561.
- B. Cores: One (1) leg per phase.
- C. Enclosure: Ventilated, NEMA 250, Type 2.
 1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.
- D. Taps for Transformers Smaller than 3 kVA: None.
- E. Taps for Transformers 7.5 to 10 kVA: Two (2) 5 percent taps below rated voltage.
- F. Taps for Transformers 15 kVA and Larger: Two (2) 2.5 percent taps above and four (4) 2.5 percent taps below normal full capacity.
- G. Insulation Class: Class R (220 deg C), UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.
- H. Energy Efficiency for Transformers Rated 15 kVA and Larger:
 1. Complying with NEMA TP 1, Class 1 efficiency levels.
 2. Tested according to NEMA TP 2.
- I. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for non-sinusoidal load current-handling capability to the degree defined by designated K-factor.

1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.
 2. Indicate value of K-factor on transformer nameplate.
- J. Wall Brackets: Manufacturer's standard brackets.
- K. Fungus Proofing: Permanent fungicidal treatment for coil and core.
- L. Low-Sound-Level Requirements: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.
- M. Low-Sound-Level Requirements: Maximum sound levels, when factory tested, shall be in according to IEEE C57.12.91.

4.03 IDENTIFICATION DEVICES

- A. Nameplates: Engraved, laminated-plastic or metal nameplate for each transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

4.04 SOURCE QUALITY CONTROL

- A. Test and inspect transformers according to IEEE C57.12.91.
- B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.
- C. Testing will also include recording of the voltages on the primary and secondary including the Impedance used.

PART 3 EXECUTION

5.01 EXAMINATION

- A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.
- B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions. Working Clearance shall not be less than 4 feet (121.92 cm) in front of the front cover. Inform engineer if there is a potential clearance problem prior to rough-in.
- C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.
- D. Verify that ground connections are in place and requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer. Install a ground copper bar for all grounding connections. Single lug grounding is not permissible.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.
- F. Grounding electrode conductor will be installed in conduit and connected with Blackburn clamps. A connection will be made to building steel and a new driven copper ground rod.

5.02 INSTALLATION

- A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer. If ceiling mounting is utilized, a letter shall be obtained and approved by a structural engineer.
1. Brace wall-mounting transformers as specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- B. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions.
- C. Install ALL floor mounted transformers as indicated on 6" housekeeping pads 4" inches larger than transformer, complying with manufacturer's written instructions, applicable requirements of

NEC, NESC, NEMA, ANSI and IEEE standards, and in accordance with recognized industry practices to ensure that products fulfill requirements. Provide NEC working clearance in front of transformers assuming they will require examination while energized.

- D. Coordinate transformer installation work with electrical raceway and wire/cable work, as necessary for proper interface.
- E. Install floor mounted units with bolts to equipment pad with neoprene/cork vibration mounts between transformer and pad. Comply with manufacturer's indicated installation method, if any.
- F. Connect transformer units to electrical wiring system with flexible metal conduit or liquid tight flexible metal conduit. Comply with the requirements of other Division 16 sections.
- G. Tighten electrical connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torque requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL STD 486A. Record torques on all terminations.
- H. Back off shipping bolts on internal vibration isolators.
- I. Provide complementary 0° and 30° phase-shift in as equal capacities for each bus as possible to maximize harmonic mitigation.

5.03 CONNECTIONS

- A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems." Install a ground copper bar to where all connections are made. Do not use single lugs. The GEC conductor shall be installed directly to XO terminal. Use grounding bushing.
- B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Carefully remove the wire insulation without damaging the copper wire strands and check all connections are to be tight.

5.04 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- B. Perform tests and inspections and prepare test reports.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
- D. Remove and replace units that do not pass tests or inspections and retest as specified above.
- E. Infrared (Baseline) Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.
 - 1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
 - 2. Perform 2 follow-up infrared scans of transformers, one at 4 months and the other at 11 months after Substantial Completion.
 - 3. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.
- F. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

- G. Provide equipment grounding connections for power/distribution transformers, sizes per NEC. Tighten connections to comply with tightening torques specified in UL STD 486A to assure permanent and effective grounding.
- H. Transformer Testing
 - 1. Certified Test Reports in accordance with TP-1-2002 and TP-2.
 - 2. Open Circuit transformer tests, for calculating percent zero-sequence impedances and reactance as follows:
 - a. With the transformer's primary terminals open-circuited, make a low impedance connection between secondary Terminals X1, X2 and X3.
 - b. Connect a variable 60HZ power source between Secondary Terminals X1, X2, X3 and X0, which includes precision revenue class voltage and current measurement instrumentation.
 - c. Increase 60HZ voltage across Terminals X1, X2, X3 and Terminal X0 until $>2/3$ full-scale readings are obtained on the voltage and current meters. In no case can the current reading exceed the full load rating of the winding under test. The values may be lower since impedance and reactance are linear.
 - d. Calculate impedance in Ohms based on the measured voltage and current values.
 - e. Based on the measured voltage, as a percentage of the rated voltage of the windings, calculate percent zero-sequence impedance and reactance.
 - 3. Closed Circuit Transformer Tests, for calculating transformer core and copper losses as follows:
 - a. In accordance with e-Rated Transformer Corporation Standard Publications VAD1-2003 and VAD2- 2003.
 - b. Measure Primary and Secondary voltage and current differences simultaneously, using 'revenue class' instrumentation and calculate excitation or no-load losses and impedances/load losses.
 - c. Submit such reports as part of shop drawings submittals for each size typical transformers, based on tests done within a year or less time.
 - d. Submit such reports for all the transformers for the project, prior to shipment.
 - 4. Design, manufacturing and testing of these transformers, in compliance with most current NEMA, IEEE and Industry standards and practices.
 - 5. Transformer Loss Calculations based on primary and secondary voltage and current differences measured simultaneously.

5.05 PROTECTION

- A. Physically protect transformers against damage. All field-repairs to be performed by and approved by factory-authorized service representative at no added cost to Owner:
 - 1. Touch-up scratches and removed paint with original factory paint.
 - 2. Replace dented plates and panels.
 - 3. Replace scratched, discolored, or otherwise damaged nameplate labels.
 - a. ADJUSTING
- B. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results. All test reports on transformers shall be compile to one database and this must be submitted to the Owner.
- C. Connect buck-boost transformers to provide nameplate voltage of equipment being served, plus or minus 5 percent, at secondary terminals.
- D. Output Settings Report: Prepare a written report recording output voltage and tap settings.
 - a. CLEANING

-
- E. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION

26 24 16

PANELBOARDS

PART 1 GENERAL

3.01 RELATED DOCUMENTS

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

3.02 SUMMARY

- A. Section Includes:
 - 1. Distribution panelboards.
 - 2. Lighting and appliance branch-circuit panelboards.

3.03 DEFINITIONS

- A. SVR: Suppressed voltage rating.
- B. SPD: Surge protective device (suppressor).

3.04 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.
- B. NEMA ICS 2 - Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts; 2008 (Reaffirmed 2020).
- C. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 1000V or Less; 2023.
- D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- E. NFPA 70E - Standard for Electrical Safety in the Workplace; 2024.

3.05 SUBMITTALS

- A. Product Data: For each type of panelboard, switching and over-current protective device, surge suppression Protective device (SPD), accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Coordination Drawings: Provide coordination drawings as described in 26 05 00 paragraph 1.03(C).
- C. Shop Drawings: For each panelboard and related equipment.
 - 1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
 - 2. Detail enclosure types and details for types other than NEMA 250, Type 1.
 - 3. Detail bus configuration, current, and voltage ratings.
 - 4. Short-circuit current rating of panelboards and over-current protective devices.
 - 5. Include evidence of NRTL listing for series rating of installed devices.
 - 6. Detail features, characteristics, ratings, and factory settings of individual over-current protective devices and auxiliary components.
 - 7. Include wiring diagrams for power, signal, and control wiring.
 - 8. Include time-current coordination curves for each type and rating of over-current protective device included in panelboards. Submit on translucent log-log graph paper; include selectable ranges for each type of over-current protective device.
 - 9. Fault current rating, brazing and bus rating
- D. Qualification Data: For qualified testing agency.

- E. Field Quality-Control Reports:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- F. Panelboard Schedules: For installation in panelboards.
- G. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. Manufacturer's written instructions for testing and adjusting over-current protective devices.
 - 2. Time-current curves, including selectable ranges for each type of over-current protective device that allows adjustments.

3.06 QUALITY ASSURANCE

- A. Source Limitations: Obtain panelboards, over-current protective devices, components, and accessories from single source from single manufacturer.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Comply with NEMA PB 1.
- E. Comply with NFPA 70.

3.07 DELIVERY, STORAGE, AND HANDLING

- A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.
- B. Handle and prepare panelboards for installation according to NEMA PB 1.

3.08 PROJECT CONDITIONS

- A. Environmental Limitations:
 - 1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
- B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
 - 1. Ambient temperatures within limits specified.
 - 2. Altitude not exceeding 6600 feet (201168 cm).
- C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify Owner no fewer than two weeks days in advance of proposed interruption of electric service.
 - 2. Comply with NFPA 70E.

3.09 COORDINATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces.

Maintain required workspace clearances and required clearances for equipment access doors and panels.

- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

3.10 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.

- 1. Warranty Period: Five years from date of Substantial Completion.

3.11 EXTRA MATERIALS

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

- 1. Keys: Two spares for each type of panelboard cabinet lock. All keys shall be turn-in to Owner.
 - 2. Circuit Breakers Including GFCI and Ground Fault Equipment Protection (GFEP) Types: Two spares for each panelboard.
 - 3. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
 - 4. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

PART 2 PRODUCTS

4.01 GENERAL REQUIREMENTS FOR PANELBOARDS

- A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- B. Enclosures: Flush- and surface-mounted cabinets, as indicated on Drawings:
 - 1. Rated for environmental conditions at installed location.
 - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
 - b. Outdoor Locations: NEMA 250, Type 3R.
 - c. Wash-Down Areas: NEMA 250, Type 4X stainless steel.
 - d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
 - e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Non-corrosive Liquids: NEMA 250, Type 5.
 - 2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
 - 3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
 - 4. Door in door Hinges: For ease of access to branch circuit wiring.
 - 5. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
 - 6. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
 - 7. Finishes:
 - 8. Panels and Trim: Steel and galvanized steel, factory finished immediately after cleaning and pre-treating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
 - a. Back Boxes: Same finish as panels and trim.
 - 9. Directory Card: Inside panelboard door, mounted in metal frame with transparent protective cover.

- C. Incoming Mains Location: Top and bottom.
- D. Phase, Neutral, and Ground Buses:
 - 1. Material: Hard-drawn Copper, 98 percent conductivity.
 - 2. Coating: Electroplated with Tin to a minimum thickness of 30 micron.
 - 3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
 - 4. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
 - 5. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads.
 - 6. Split Bus: Vertical buses divided into individual vertical sections.
- E. Conductor Connectors: Suitable for use with conductor material and sizes.
 - 1. Material: Hard-drawn copper, 98 percent conductivity.
 - 2. Main and Neutral Lugs: Mechanical type.
 - 3. Ground Lugs and Bus-Configured Terminators: Mechanical type.
 - 4. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
 - 5. Sub-feed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
 - 6. Gutter-Tap Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
 - 7. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.
- F. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and over-current protective devices.
- G. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
- H. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Series-connected ratings are not acceptable.

4.02 DISTRIBUTION PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Square D / Schneider Electric
 - 2. Cutler-Hammer / Eaton
 - 3. General Electric / ABB
 - 4. Siemens
- B. Panelboards: NEMA PB 1, power and feeder distribution type.
- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
 - 1. For doors more than 36 inches (914.4 mm) high, provide two latches, keyed alike.
- D. Mains: Circuit breaker.
- E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.
- F. Branch Over-current Protective Devices for Circuit-Breaker Frame Sizes Larger than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.
- G. Branch Over-current Protective Devices: Circuit Breaker.

- H. Contactors in Main Bus: NEMA ICS 2, Class A, mechanically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.
 - 1. Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.

4.03 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Square D / Schneider Electric
 - 2. Cutler-Hammer / Eaton
 - 3. General Electric / ABB
 - 4. Siemens
- B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- C. Mains: Circuit breaker.
- D. Branch Over-current Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- E. Contactors in Main Bus: NEMA ICS 2, Class A, mechanically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.
 - 1. Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.
- F. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.
- G. Column-Type Panelboards: Narrow gutter extension, with cover, to overhead junction box equipped with ground and neutral terminal buses.
- H. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Series-connected ratings are not acceptable.

4.04 ACCESSORY COMPONENTS AND FEATURES

- A. Accessory Set: Include tools and miscellaneous items required for over-current protective device test, inspection, maintenance, and operation.
- B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

PART 3 EXECUTION

5.01 EXAMINATION

- A. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.
- B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.
- C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

5.02 INSTALLATION

- A. Install panelboards and accessories according to NEMA PB 1.1.
- B. Equipment Mounting: Install panelboards on concrete bases, 4-inch nominal thickness.
 - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.
 - 2. For panelboards, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.

3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to panelboards.
5. Attach panelboard to the vertical finished or structural surface behind the panelboard.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
- D. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- E. Mount top of trim 90 inches (2286 mm) above finished floor unless otherwise indicated.
- F. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box. Mount surface panelboards on 1-5/8 x 1-5/8 Unistrut not on wall surface.
- G. Install over-current protective devices and controllers not already factory installed.
 1. Set field-adjustable, circuit-breaker trip ranges.
- H. Install filler plates in unused spaces.
- I. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade. All empty conduits shall be enclosed or sealed.
- J. All conduits, junction boxes, pull boxes and entering and leaving shall be marked or label with circuit numbers.
- K. Conductors inside the panelboards shall be install neat, order and workmanlike manner. Comply and refer to NEC Article 312.
- L. Comply with NECA 1.

5.03 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
- D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

5.04 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Acceptance Testing Preparation:
 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 2. Test continuity of each circuit.

- D. Tests and Inspections:
1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 3. Perform the following infrared scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
 - c. Instruments and Equipment:
 - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
- E. Panelboards will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection report, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

5.05 ADJUSTING

- A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as indicated.
- C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.
1. Measure as directed during period of normal system loading.
 2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
 3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
 4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

5.06 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.
- B. Physically protect panelboards against damage. All field-repairs to be performed by and approved by factory-authorized service representative at no added cost to Owner:
1. Touch-up scratches and removed paint with original factory paint.
 2. Replace dented plates and panels.
 3. Repair or replace damaged or non-functional devices.
 4. Replace scratched, discolored, or otherwise damaged nameplate or device identification labels.
- a. CLEANING
- C. Vacuum dirt and debris; do not use compressed air to assist in cleaning.
- D. Clean the outside and inside the switchboards free from dust.

END OF SECTION

26 27 13

ELECTRICITY METERING

PART 1 GENERAL

3.01 RELATED DOCUMENTS

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

3.02 SUMMARY

- A. Section includes equipment for electricity metering by Owner.

3.03 DEFINITIONS

- A. KY Pulse: Term used by the metering industry to describe a method of measuring consumption of electricity that is based on a relay opening and closing in response to the rotation of the disk in the meter.
- B. PC: Personal computer.

3.04 REFERENCE STANDARDS

- A. ANSI C12.20 - American National Standard for Electricity Meters - 0.1, 0.2, and 0.5 Accuracy Classes; 2022.
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.
- C. NECA 400 - Standard for Installing and Maintaining Switchboards; 2007.
- D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

3.05 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For electricity-metering equipment.
 - 1. Dimensioned plans and sections or elevation layouts.
 - 2. Wiring Diagrams: For power, signal, and control wiring. Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features.
- C. Field quality-control reports.
- D. Operation and Maintenance Data. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. Application and operating software documentation.
 - 2. Software licenses.
 - 3. Software service agreement.
 - 4. Hard copies of manufacturer's operating specifications, design user's guides for software and hardware, and PDF files on CD-ROM of the hard-copy Submittal.

3.06 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

3.07 DELIVERY, STORAGE, AND HANDLING

- A. Receive, store, and handle modular meter center according to NECA 400.

3.08 PROJECT CONDITIONS

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
 - 1. Notify Owner no fewer than two weeks in advance of proposed interruption of electrical service.
 - 2. Do not proceed with interruption of electrical service without Owner's written permission.

3.09 COORDINATION

- A. Electrical Service Connections: Coordinate with utility companies and components they furnish as follows:
 - 1. Comply with requirements of utilities providing electrical power services.
 - 2. Coordinate installation and connection of utilities and services, including provision for electricity-metering components.

3.10 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning with Substantial Completion, provide software support for two years.
- B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.
 - 1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade his computer equipment if necessary.

PART 2 PRODUCTS

4.01 EQUIPMENT FOR ELECTRICITY METERING BY OWNER

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Square D / Schneider Electric
 - 2. E-Mon
 - 3. National Meter Industries
 - 4. General Electric / ABB
 - 5. Eaton
- B. General Requirements for Owner's Meters:
 - 1. Comply with UL 1244.
 - 2. Meters used for billing shall have an accuracy of 1.0 percent of reading, complying with requirements in ANSI C12.20.
 - 3. Enclosure: NEMA 250, Type 1 minimum, with hasp for padlocking or sealing.
 - 4. Identification: Comply with requirements in Division 26 Section "Identification for Electrical Systems."
 - 5. Memory Backup: Self-contained to maintain memory throughout power outages of 72 hours, minimum.
 - 6. Sensors: Current-sensing type, with current or voltage output, selected for optimum range and accuracy for meters indicated for this application.
 - a. Type: Split and solid core.
 - 7. Current-Transformer Cabinet: Listed or recommended by metering equipment manufacturer for use with sensors indicated.
 - 8. Building Automation System (BAS) Interface: One digital KY pulse to a user-definable increment of energy measurement. Match signal to BAS input and arrange to convey the

instantaneous, integrated, demand level measured by meter to provide data for processing and possible programmed demand control action by destination system.

- C. Kilowatt-hour Meter: Electronic three-phase meters, measuring electricity used.
 - 1. Voltage and Phase Configuration: Meter shall be designed for use on circuits with voltage rating and phase configuration indicated for its application.
 - 2. Display: LCD with characters not less than 0.25-inch-high, indicating accumulative kilowatt-hours and current kilowatt load. Retain accumulated kilowatt-hour in a nonvolatile memory, until reset.
 - 3. Display: Digital electromechanical counter, indicating accumulative kilowatt-hours.
- D. Kilowatt-hour/Demand Meter: Electronic three-phase meters, measuring electricity use and demand. Demand shall be integrated over a 15-minute interval.
 - 1. Voltage and Phase Configuration: Meter shall be designed for use on circuits with voltage rating and phase configuration indicated for its application.
 - 2. Display: LCD with characters not less than 0.25-inch-high, indicating accumulative kilowatt-hours, current time and date, current demand, and historic peak demand, and time and date of historic peak demand. Retain accumulated kilowatt-hour and historic peak demand in a nonvolatile memory, until reset.
- E. Data Transmission Cable: Transmit KY pulse data over Class 1 control-circuit conductors in raceway. Comply with Division 26 Section "Control-Voltage Electrical Power Cables."
- F. Software: PC-based, a product of meter manufacturer, suitable for calculation of utility cost allocation and billing.

PART 3 EXECUTION

5.01 INSTALLATION

- A. Comply with equipment installation requirements in NECA 1.
- B. Install meters furnished by utility company. Install raceways and equipment according to utility company's written requirements. Provide empty conduits for metering leads and extend grounding connections as required by utility company.
- C. Install modular meter center according to NECA 400 switchboard installation requirements.

5.02 IDENTIFICATION

- A. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
 - 1. Series Combination Warning Label: Self-adhesive type, with text as required by NFPA 70.
 - 2. Equipment Identification Labels: Adhesive film labels with clear protective overlay. For residential meters, provide an additional card holder suitable for typewritten card with occupant's name.

5.03 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
 - 1. Connect a load of known kilowatt rating, 15 kW minimum, to a circuit supplied by metered feeder.
 - 2. Turn off circuits supplied by metered feeder and secure them in off condition.
 - 3. Run test load continuously for eight hours minimum, or longer, to obtain a measurable meter indication. Use test-load placement and setting that ensures continuous, safe operation.

- 4. Check and record meter reading at end of test period and compare with actual electricity used, based on test-load rating, duration of test, and sample measurements of supply voltage at test-load connection. Record test results.
- C. Electricity metering will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

END OF SECTION

26 27 26

WIRING DEVICES

PART 1 GENERAL

3.01 RELATED DOCUMENTS

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

3.02 SUMMARY

- A. This Section includes the following:
 - 1. Receptacles, receptacles with integral GFCI, and associated device plates.
 - 2. Twist-locking receptacles.
 - 3. Receptacles with integral surge suppression units.
 - 4. Hospital Grade
 - 5. Wall-box motion sensors.
 - 6. Isolated-ground receptacles.
 - 7. Snap switches and wall-box dimmers.
 - 8. Wall-switch and exterior occupancy sensors.
 - 9. Communications outlets.
 - 10. Pendant cord-connector devices.
 - 11. Cord and plug sets.
 - 12. Floor service outlets, poke-through assemblies, service poles, and multi-outlet assemblies.

3.03 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- D. RFI: Radio-frequency interference.
- E. SPD: Surge suppressor protective device.
- F. UTP: Unshielded twisted pair.

3.04 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.
- B. NEMA WD 6 - Wiring Devices - Dimensional Specifications; 2021.
- C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D. NFPA 99 - Health Care Facilities Code; 2024, with Errata.
- E. UL 20 - General-Use Snap Switches; Current Edition, Including All Revisions.
- F. UL 498 - Attachment Plugs and Receptacles; Current Edition, Including All Revisions.
- G. UL 943 - Ground-Fault Circuit-Interrupters; Current Edition, Including All Revisions.
- H. UL 1472 - Solid-State Dimming Controls; Current Edition, Including All Revisions.
- I. UL 1863 - Communications-Circuit Accessories; Current Edition, Including All Revisions.

3.05 SUBMITTALS

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

- B. Shop Drawings: List of legends and description of materials and process used for pre-marking wall plates.
- C. Samples: One for each type of device and wall plate specified, in each color specified.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

3.06 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NFPA 70.

3.07 COORDINATION

- A. Receptacles for Owner-Furnished Equipment: Match plug configuration.
 - 1. Cord and Plug Sets: Match equipment requirements.

3.08 EXTRA MATERIALS

- A. Furnish extra materials described in subparagraphs below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Service/Power Poles: One for every 10, but no less than one.
 - 2. Floor Service Outlet Assemblies: One for every 10 but no less than one.
 - 3. Poke-Through, Fire-Rated Closure Plugs: One for every five floor service outlets installed, but no fewer than two.
 - 4. TVSS Receptacles: One for every 10 of each type installed, but no fewer than two of each type.

PART 2 PRODUCTS

4.01 MANUFACTURERS

- A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
 - 1. Pass & Seymour/Legrand
 - 2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
 - 3. Leviton Mfg. Company Inc. (Leviton).

4.02 STRAIGHT BLADE RECEPTACLES

- A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Pass & Seymour/Legrand ; 5381 (single), 5352 (duplex).
 - b. Hubbell; HBL5351 (single), CR5352 (duplex).
 - c. Leviton; 5891 (single), 5352 (duplex).
- B. Tamper-Resistant Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Pass & Seymour; 63H
 - b. Hubbell; HBL8300SG.

- c. Leviton; 8300-SGG.
- 2. Description: Labeled to comply with NFPA 70, "Health Care Facilities" Article, "Pediatric Locations" Section.

4.03 GFCI RECEPTACLES

- A. General Description: Straight blade, feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.
- B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Pass & Seymour/Legrand; 2084.

4.04 TWIST-LOCKING RECEPTACLES

- A. Single Receptacles: Comply with NEMA WD 1, NEMA WD 6 configuration and ratings as indicated on Drawings, and UL 498.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Pass & Seymour/Legrand
 - b. Hubbell
 - c. Leviton
- B. Isolated-Ground, Single Receptacles:
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Hubbell
 - b. Leviton
 - c. Pass & Seymour/Legrand
 - 2. Description: Comply with NEMA WD 1, NEMA WD 6 configuration L5-20R, and UL 498. Equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

4.05 PENDANT CORD-CONNECTOR DEVICES

- A. Description: Matching, locking-type plug and receptacle body connector; NEMA WD 6 configurations L5-20P and L5-20R, heavy-duty grade.
 - 1. Body: Nylon with screw-open cable-gripping jaws and provision for attaching external cable grip.
 - 2. External Cable Grip: Woven wire-mesh type made of high-strength galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

4.06 CORD AND PLUG SETS

- A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.
 - 1. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and equipment-rating ampacity plus a minimum of 30 percent.
 - 2. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

4.07 SNAP SWITCHES

- A. Comply with NEMA WD 1 and UL 20.
- B. Switches, 120/277 V, 20 A:
 - 1. Products: Subject to compliance with requirements, provide one of the following:

-
- a. Pass & Seymour/Legrand; 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way), 20AC4 (four way).
 - b. Hubbell; CS1221 (single pole), CS1222 (two pole), CS1223 (three way), CS1224 (four way).
 - c. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).
 - C. Pilot Light Switches, 20 A:
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Pass & Seymour/Legrand; PS20AC1-PLR for 120 V.
 - b. Hubbell; HPL1221PL for 120 V and 277 V.
 - c. Leviton; 1221-PLR for 120 V, 1221-7PLR for 277 V.
 - 2. Description: Single pole, with neon-lighted handle, illuminated when switch is "ON."
 - D. Key-Operated Switches, 120/277 V, 20 A:
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Pass & Seymour/Legrand; PS20AC1-L.
 - b. Hubbell; HBL1221L.
 - c. Leviton; 1221-2L.
 - 2. Description: Single pole, with factory-supplied key in lieu of switch handle.
 - E. Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Pass & Seymour/Legrand; 1251.
 - b. Hubbell; HBL1557.
 - c. Leviton; 1257.
 - F. Key-Operated, Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Pass & Seymour/Legrand; 1251L.
 - b. Hubbell; HBL1557L.
 - c. Leviton; 1257L.

4.08 WALL-BOX DIMMERS

- A. Dimmer Switches: By same manufacturer of other devices to match dimming technology of connected light fixtures.
- B. Control: Continuously adjustable slider; with single-pole or three-way switching. Comply with UL 1472.

4.09 OCCUPANCY SENSORS

- A. Wall-Switch Sensors:
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Pass & Seymour/Legrand
 - b. Hubbell
 - c. Leviton
 - d. Watt Stopper
 - 2. Description: Dual technology Passive-infrared type/Ultrasonic, 120/277 V, adjustable time delay up to 30 minutes, 180-degree field of view, with a minimum coverage area of 900 sq. ft.
- B. Long-Range Wall-Switch Sensors:
 - 1. Products: Subject to compliance with requirements, provide one of the following:

-
- a. Hubbell; ATD1600WRP.
 - b. Leviton; ODW12-MRW.
 - c. Watt Stopper (The); DT-200.
 - d. Pass & Seymour/Legrand
 - 2. Description: Dual technology, with both passive-infrared- and ultrasonic-type sensing, 120/277 V, adjustable time delay up to 30 minutes, 110-degree field of view, and a minimum coverage area of 1200 sq. ft.
- C. Wide-Range Wall-Switch Sensors:
- 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Hubbell; ATP120HBRP.
 - b. Leviton; ODWHB-IRW.
 - c. Pass & Seymour; HS1001.
 - d. Watt Stopper (The); CX-100-3.
 - 2. Description: Passive-infrared type, 120/277 V, adjustable time delay up to 30 minutes, 150-degree field of view, with a minimum coverage area of 1200 sq. ft.
- D. Exterior Occupancy Sensors:
- 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Leviton; PS200-10.
 - b. Watt Stopper (The); EW-100-120.
 - c. Pass & Seymour/Legrand
 - 2. Description: Passive-infrared type, 120/277 V, weatherproof, adjustable time delay up to 15 minutes, 180-degree field of view, and 110-foot detection range. Minimum switch rating: 1000-W incandescent, 500-VA fluorescent.
- 4.10 COMMUNICATIONS OUTLETS
- A. Telephone Outlet:
- 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 3560-6.
 - b. Leviton; 40649.
 - 2. Description: Single RJ-45 jack for terminating 100-ohm, balanced, four-pair UTP; TIA/EIA-568-B.1; complying with Category 5e. Comply with UL 1863.
- B. Combination TV and Telephone Outlet:
- 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 3562.
 - b. Leviton; 40595.
 - 2. Description: Single RJ-45 jack for 100-ohm, balanced, four-pair UTP; TIA/EIA-568-B.1; complying with Category 5e; and one Type F coaxial cable connector.
- 4.11 WALL PLATES
- A. Single and combination types to be 302/304 stainless steel.
 - B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant thermoplastic with lockable cover.
- 4.12 FLOOR SERVICE FITTINGS
- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Hubbell Incorporated; System One.
 - B. Type: Modular, flush-type, dual-service units suitable for wiring method used.
 - C. Compartments: Barrier separates power from voice and data communication cabling.
 - D. Service Plate: Rectangular, solid brass, coordinate finish with Architect prior to ordering.

- E. Power Receptacle: NEMA WD 6 configuration 5-20R, gray finish, unless otherwise indicated.
- F. Voice and Data Communication Outlet: Blank cover with bushed cable opening.

4.13 POKE-THROUGH ASSEMBLIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Hubbell Incorporated; System One.
- B. Description: Factory-fabricated and -wired assembly of below-floor junction box with multi-channelled, through-floor raceway/fire-stop unit and detachable matching floor service outlet assembly.
 - 1. Service Outlet Assembly: Pedestal type with services indicated.
 - 2. Size: Selected to fit nominal 3-inch cored holes in floor and matched to floor thickness.
 - 3. Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.
 - 4. Closure Plug: Arranged to close unused 3-inch cored openings and reestablish fire rating of floor.
 - 5. Wiring Raceways and Compartments: For a minimum of four No. 12 AWG conductors and a minimum of four, 4-pair, Category 5e voice and data communication cables.

4.14 MULTIOUTLET ASSEMBLIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Hubbell Incorporated; Wiring Device-Kellems.
- B. Components of Assemblies: Products from a single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.
- C. Raceway Material: Metal, with manufacturer's standard finish.
- D. Wire: Minimum No. 12 AWG.

4.15 SERVICE POLES

- A. Description: Factory-assembled and -wired units to extend power and voice and data communication from distribution wiring concealed in ceiling to devices or outlets in pole near floor.
 - 1. Poles: Nominal 2.5-inch square cross section, with height adequate to extend from floor to at least 6 inches (152.4 mm) above ceiling, and with separate channels for power wiring and voice and data communication cabling.
 - 2. Mounting: Ceiling trim flange with concealed bracing arranged for positive connection to ceiling supports; with pole foot and carpet pad attachment.
 - 3. Finishes: Manufacturer's standard painted finish and trim combination.
 - 4. Wiring: Sized for minimum of five No. 12 AWG power and ground conductors and a minimum of four, 4-pair, Category 3 or 5 voice and data communication cables.
 - 5. Power Receptacles: Two duplex, 20-A, heavy-duty, NEMA WD 6 configuration 5-20R units.
 - 6. Voice and Data Communication Outlets: Blank insert with bushed cable opening.

4.16 FINISHES

- A. Color: Wiring device catalog numbers in Section Text do not designate device color.
 - 1. Wiring Devices Connected to Normal Power System: Ivory, or as selected by Architect unless otherwise indicated or required by NFPA 70 or device listing.
 - 2. Wiring Devices Connected to Emergency Power System: Red.
 - 3. TVSS Devices: Blue.
 - 4. Isolated-Ground Receptacles: Orange.

PART 3 EXECUTION

5.01 INSTALLATION

- A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.
- B. Coordination with Other Trades:
 - 1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes. Cut holes need not to be more than 1/8" inch in all sides of the box.
 - 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
 - 3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
 - 4. Boxes and conduit shall be rigidly supported to the wall. Do not use spacer type supports.
 - 5. Install wiring devices after all wall preparation, including painting, is complete.
 - 6. Do not use extension ring in any applications.
- C. Conductors:
 - 1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
 - 2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
 - 3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300.14, without pigtails. Multiple duplex receptacles shall be use pigtail and use the screw terminals to terminate the wire not the back of the receptacle outlet.
 - 4. Conductors shall be identified with circuit number at the box.
 - 5. Existing Conductors:

CUT BACK AND PIGTAIL OR REPLACE ALL DAMAGED CONDUCTORS.

- a. Straighten conductors that remain and remove corrosion and foreign matter.
 - b. Pigtailling existing conductors is permitted provided the outlet box is large enough.
- B. Device Installation:
 - 1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
 - 2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
 - 3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
 - 4. Connect devices to branch circuits using pigtails that are not less than 6 inches (152.4 mm) in length.
 - 5. Use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
 - 6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
 - 7. When conductors larger than No. 12 AWG are installed on 20-A circuits, splice No. 12 AWG pigtails for device connections.
 - 8. Tighten unused terminal screws on the device.
 - 9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.
- C. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the right.
 2. Install hospital-grade receptacles in patient-care areas with the ground pin or neutral blade at the top.
- D. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.
- E. Dimmers:
1. Install dimmers within terms of their listing.
 2. Verify that dimmers used for fan speed control are listed for that application.
 3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.
- F. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multi-gang wall plates.
- G. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

6.02 IDENTIFICATION

- A. Comply with Division 26 Section "Identification for Electrical Systems."
1. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.
 2. Receptacles: Label or mark the cover with panel and circuit number back and front cover.

6.03 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
1. In healthcare facilities, prepare reports that comply with recommendations in NFPA 99.
 2. Test Instruments: Use instruments that comply with UL 1436.
 3. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.
- B. Tests for Convenience Receptacles:
1. Line Voltage: Acceptable range is 105 to 132 V.
 2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.
 3. Ground Impedance: Values of up to 2 ohms are acceptable.
 4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
 5. Using the test plug, verify that the device and its outlet box are securely mounted.
 6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

END OF SECTION

26 28 13

FUSES

PART 1 GENERAL

3.01 REFERENCE STANDARDS

- A. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

3.02 RELATED DOCUMENTS

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

3.03 SUMMARY

- A. Section Includes:
 - 1. Cartridge fuses rated 600-V ac and less for use in control circuits, enclosed switches, panelboards, switchboards, enclosed controllers, and motor-control centers.
 - 2. Plug fuses rated 125-V ac and less for use in plug-fuse-type enclosed switches, fuse-holders, and panelboards.
 - 3. Plug-fuse adapters for use in Edison-base, plug-fuse sockets.
 - 4. Spare-fuse cabinets.

3.04 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:
 - 1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
 - a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
 - b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
 - 2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
 - 3. Current-limitation curves for fuses with current-limiting characteristics.
 - 4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
 - 5. Coordination charts and tables and related data.
 - 6. Fuse sizes for elevator feeders and elevator disconnect switches.
- B. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. Ambient temperature adjustment information.
 - 2. Current-limitation curves for fuses with current-limiting characteristics.
 - 3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
 - 4. Coordination charts and tables and related data.

3.05 QUALITY ASSURANCE

- A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

- C. Comply with NEMA FU 1 for cartridge fuses.
- D. Comply with NFPA 70.
- E. Comply with UL 248-11 for plug fuses.

3.06 COORDINATION

- A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

3.07 EXTRA MATERIALS

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

PART 2 PRODUCTS

4.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper Bussmann, Inc.
 - 2. Littelfuse, Inc.

4.02 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

4.03 PLUG FUSES

- A. Characteristics: UL 248-11, nonrenewable plug fuses; 125-V ac.

4.04 PLUG-FUSE ADAPTERS

- A. Characteristics: Adapters for using Type S, rejection-base plug fuses in Edison-base fuse-holders or sockets; ampere ratings matching fuse ratings; irremovable once installed.

4.05 SPARE-FUSE CABINET

PART 3 EXECUTION

5.01 EXAMINATION

- A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.
- B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.
- C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

5.02 FUSE APPLICATIONS

- A. Cartridge Fuses:
 - 1. Service Entrance: Class L, fast acting.
 - 2. Feeders: Class L, fast acting
 - 3. Motor Branch Circuits: Class RK1 and Class RK5, time delay.
 - 4. Other Branch Circuits: Class J, fast acting.
 - 5. Control Circuits: Class CC, fast acting.

5.03 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.
- B. Install plug-fuse adapters in Edison-base fuse-holders and sockets. Ensure that adapters are irremovable once installed.
- C. Install spare-fuse cabinet(s).

5.04 IDENTIFICATION

- A. Install labels complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION

26 28 16

ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 GENERAL

3.01 RELATED DOCUMENTS

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

3.02 SUMMARY

- A. Section Includes:
 - 1. Fusible switches.
 - 2. Non-fusible switches.
 - 3. Receptacle switches.
 - 4. Shunt trip switches.
 - 5. Molded-case circuit breakers.
 - 6. Enclosures.

3.03 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

3.04 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.
- B. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- C. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
- D. UL 98 - Enclosed and Dead-Front Switches; Current Edition, Including All Revisions.
- E. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.
- F. UL 1053 - Ground-Fault Sensing and Relaying Equipment; Current Edition, Including All Revisions.

3.05 SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
 - 1. Enclosure types and details for types other than NEMA 250, Type 1.
 - 2. Current and voltage ratings.
 - 3. Short-circuit current ratings (interrupting and withstand, as appropriate).
 - 4. Detail features, characteristics, ratings, and factory settings of individual over-current protective devices, accessories, and auxiliary components.
 - 5. Include time-current coordination curves (average melt) for each type and rating of over-current protective device; include selectable ranges for each type of over-current protective device.
- B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Wiring Diagrams: For power, signal, and control wiring.

- C. Qualification Data: For qualified testing agency.
- D. Seismic Qualification Certificates: For enclosed switches and circuit breakers, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- E. Field quality-control reports.
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- F. Manufacturer's field service report.
- G. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
 - 2. Time-current coordination curves (average melt) for each type and rating of over-current protective device; include selectable ranges for each type of over-current protective device.

3.06 QUALITY ASSURANCE

- A. Source Limitations: Obtain enclosed switches and circuit breakers, over-current protective devices, components, and accessories, within same product category, from single source from single manufacturer.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Comply with NFPA 70.

3.07 COORDINATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

3.08 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
 - 2. Fuse Pullers: Two for each size and type.

PART 2 PRODUCTS

4.01 FUSIBLE SWITCHES

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

-
1. Square D / Schneider Electric
 2. Cutler-Hammer / Eaton
 3. General Electric / ABB
 4. Siemens
- B. Type HD, Heavy Duty, Six Pole, Single Throw, 600-V ac, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Type HD, Heavy Duty, Double Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- D. Accessories:
1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 3. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
 5. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
 6. Hook stick Handle: Allows use of a hook stick to operate the handle.
 7. Lugs: Mechanical type, suitable for number, size, and conductor material.
 8. Service-Rated Switches: Labeled for use as service equipment.
 9. Accessory Control Power Voltage: Remote mounted and powered; 120-V ac.

4.02 NONFUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Square D / Schneider Electric
 2. Cutler-Hammer / Eaton
 3. General Electric / ABB
 4. Siemens
- B. Type HD, Heavy Duty, Single Throw, 240, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Type HD, Heavy Duty, Six Pole, Single Throw, 240, 600-V ac, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- D. Type HD, Heavy Duty, Double Throw, 240, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- E. Accessories:
1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 3. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.

4. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
5. Hook-stick Handle: Allows use of a hook-stick to operate the handle.
6. Lugs: Mechanical type, suitable for number, size, and conductor material.
7. Accessory Control Power Voltage: Remote mounted and powered; 120-V ac.

4.03 MOLDED-CASE CIRCUIT BREAKERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Square D / Schneider Electric
 2. Cutler-Hammer / Eaton
 3. General Electric / ABB
 4. Siemens
- B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.
- C. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
- D. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
- E. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
 1. Instantaneous trip.
 2. Long- and short-time pickup levels.
 3. Long- and short-time time adjustments.
 4. Ground-fault pickup level, time delay, and I₂t response.
- F. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.
- G. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker and trip activation on fuse opening or on opening of fuse compartment door.
- H. Ground-Fault, Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
- I. Ground-Fault, Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).
- J. Features and Accessories:
 1. Standard frame sizes, trip ratings, and number of poles.
 2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
 3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
 4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
 5. Communication Capability: Integral communication module with functions and features compatible with power monitoring and control system, specified in Division 26 Section "Electrical Power Monitoring and Control."
 6. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.

7. Under-voltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
8. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
9. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
10. Electrical Operator: Provide remote control for on, off, and reset operations.

4.04 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
 2. Outdoor Locations: NEMA 250, Type 3R.
 3. Kitchen and Wash-Down Areas: NEMA 250, Type 4X, SS-304.
 4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4X SS-304.
 5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Non-corrosive Liquids: NEMA 250, Type 12.
 6. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7.

PART 3 EXECUTION

5.01 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

5.02 INSTALLATION

- A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- B. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- D. Install fuses in fusible devices.
- E. Comply with NECA 1.

5.03 IDENTIFICATION

- A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."
 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

5.04 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Acceptance Testing Preparation:
 1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
 2. Test continuity of each circuit.
- C. Tests and Inspections:

-
1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 3. Perform the following infrared scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.
 - c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection report, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken and observations after remedial action.

5.05 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.

END OF SECTION 26 28 16

THIS PAGE INTENTIONALLY LEFT BLANK.

END OF SECTION

26 29 13

ENCLOSED CONTROLLERS

PART 1 GENERAL

3.01 RELATED DOCUMENTS

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

3.02 SUMMARY

- A. Section includes the following enclosed controllers rated 600V and less:
 - 1. Full-voltage manual.
 - 2. Full-voltage magnetic.
 - 3. Reduced-voltage magnetic.
 - 4. Reduced-voltage solid state.
 - 5. Multi-speed.
- B. Related Section:
 - 1. Division 26 Section "Variable-Frequency Motor Controllers" for general-purpose, ac, adjustable-frequency, pulse-width-modulated controllers for use on variable torque loads in ranges up to 200HP.

3.03 DEFINITIONS

- A. CPT: Control power transformer.
- B. MCCB: Molded-case circuit breaker.
- C. MCP: Motor circuit protector.
- D. N.C.: Normally closed.
- E. N.O.: Normally open.
- F. OCPD: Over-current protective device.
- G. SCR: Silicon-controlled rectifier.

3.04 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.
- B. NEMA ICS 2 - Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts; 2008 (Reaffirmed 2020).
- C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D. NFPA 70E - Standard for Electrical Safety in the Workplace; 2024.
- E. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.

3.05 SUBMITTALS

- A. Product Data: For each type of enclosed controller. Include manufacturer's technical data on features, performance, electrical characteristics, ratings, and enclosure types and finishes.
- B. Shop Drawings: For each enclosed controller. Include dimensioned plans, elevations, sections, details, and required clearances and service spaces around controller enclosures.
 - 1. Show tabulations of the following:
 - a. Each installed unit's type and details.
 - b. Factory-installed devices.
 - c. Nameplate legends.

- d. Short-circuit current rating of integrated unit.
 - e. Listed and labeled for integrated short-circuit current (withstand) rating of OCPDs in combination controllers by an NRTL acceptable to authorities having jurisdiction.
 - f. Features, characteristics, ratings, and factory settings of individual OCPDs in combination controllers.
- 2. Wiring Diagrams: For power, signal, and control wiring.
- C. Qualification Data: For qualified testing agency.
- D. Seismic Qualification Certificates: For enclosed controllers, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- E. Field quality-control reports.
- F. Operation and Maintenance Data: For enclosed controllers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. Routine maintenance requirements for enclosed controllers and installed components.
 - 2. Manufacturer's written instructions for testing and adjusting circuit breaker and MCP trip settings.
 - 3. Manufacturer's written instructions for setting field-adjustable overload relays.
 - 4. Manufacturer's written instructions for testing, adjusting, and reprogramming reduced-voltage solid-state controllers.
- G. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.
- H. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor running overload protection suit actual motors to be protected.

3.06 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.
 - 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NFPA 70.
- D. IEEE Compliance: Fabricate and test enclosed controllers according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

3.07 DELIVERY, STORAGE, AND HANDLING

- A. Store enclosed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- B. If stored in areas subject to weather, cover enclosed controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers.

3.08 PROJECT CONDITIONS

- A. Interruption of Existing Electrical Systems: Do not interrupt electrical systems in facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
 - 1. Notify Owner no fewer than 10 days in advance of proposed interruption of electrical systems.
 - 2. Indicate method of providing temporary utilities.
 - 3. Do not proceed with interruption of electrical systems without Owner's written permission.
 - 4. Comply with NFPA 70E.

3.09 COORDINATION

- A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- C. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

3.10 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than 3 of each size and type.
 - 2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than 2 of each size and type.
 - 3. Indicating Lights: 2 of each type and color installed.
 - 4. Auxiliary Contacts: Furnish 1 spare(s) for each size and type of magnetic controller installed.
 - 5. Power Contacts: Furnish 3 spares for each size and type of magnetic contactor installed.

PART 2 PRODUCTS

4.01 FULL-VOLTAGE CONTROLLERS

- A. General Requirements for Full-Voltage Controllers: Comply with NEMA ICS 2, general purpose, Class A.
- B. Motor-Starting Switches: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off or on.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Square D.
 - b. GE.
 - c. Cutler-Hammer.
 - d. Asco
 - 2. Configuration: Non-Reversing.
 - 3. Surface mounting.
 - 4. Red pilot light.
- C. Fractional Horsepower Manual Controllers: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following
 - a. Square D.

-
- b. GE.
 - c. Cutler-Hammer.
 - d. Asco
 - 2. Configuration: Non-reversing.
 - 3. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button.
 - 4. Surface mounting.
 - 5. Not all manufacturers offer a green pilot light; pilot lights are not available in hazardous and some cast-type enclosures.
 - 6. Red pilot light.
- D. Magnetic Controllers: Full voltage, across the line, electrically held.
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Square D.
 - b. GE.
 - c. Cutler-Hammer.
 - d. Asco
 - 2. Configuration: Non-reversing.
 - 3. Power Contacts: Totally enclosed, double-break, silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
 - 4. Control Circuits: 120 V ac; obtained from integral CPT, with primary and secondary fuses and sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
 - 5. Solid-State Overload Relay:
 - a. Switch or dial selectable for motor running overload protection.
 - b. Sensors in each phase.
 - c. Class 10/20 selectable tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
 - d. Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
 - e. Analog communication module.
 - 6. External overload reset push button.
- E. Combination Magnetic Controller: Factory-assembled combination of magnetic controller, OCPD, and disconnecting means.
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following
 - a. Square D / Schneider Electric
 - b. Cutler-Hammer / Eaton
 - c. General Electric / ABB
 - d. Siemens
 - 2. MCP Disconnecting Means:
 - a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
 - b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
 - c. Auxiliary contacts "a" and "b" arranged to activate with MCP handle.
 - d. N.C. alarm contact that operates only when MCP has tripped.
 - e. Current-limiting module to increase controller short-circuit current (withstand) rating to 100 kA.

3. MCCB Disconnecting Means:
 - a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
 - b. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - c. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
 - d. Auxiliary contacts "a" and "b" arranged to activate with MCCB handle.
 - e. N.C. alarm contact that operates only when MCCB has tripped.

4.02 ENCLOSURES

- A. Enclosed Controllers: NEMA ICS 6, to comply with environmental conditions at installed location.
 1. Dry and Clean Indoor Locations: Type 1.
 2. Outdoor Locations: Type 3R.
 3. Kitchen and Wash-Down Areas: Type 4X, stainless steel.
 4. Other Wet or Damp Indoor Locations: Type 4X-ss.
 5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Non-corrosive Liquids: Type 12.
 6. Hazardous Areas Indicated on Drawings: Type 9.

4.03 ACCESSORIES

- A. General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.
 1. Push Buttons, Pilot Lights, and Selector Switches: Heavy duty, oil-tight type.
- B. N.C., N.O. auxiliary contact(s).
- C. Control Relays: Auxiliary and adjustable solid-state time-delay relays.
- D. Phase-Failure, Phase-Reversal, and Under-voltage and Over-voltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable under-voltage, over-voltage, and time-delay settings.
- E. Breather and drain assemblies, to maintain interior pressure and release condensation in Type 4X enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.
- F. Space heaters, with N.C. auxiliary contacts, to mitigate condensation in Type 3R enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.
- G. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.
- H. Cover gaskets for Type 1 enclosures.
- I. Terminals for connecting power factor correction capacitors to the load side of overload relays.
- J. Spare control wiring terminal blocks, quantity as indicated; unwired.

PART 3 EXECUTION

5.01 EXAMINATION

- A. Examine areas and surfaces to receive enclosed controllers, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
- B. Examine enclosed controllers before installation. Reject enclosed controllers that are wet, moisture damaged, or mold damaged.

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

5.02 INSTALLATION

- A. Wall-Mounted Controllers: Install enclosed controllers on walls with tops at uniform height unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."
- B. Floor-Mounted Controllers: Install enclosed controllers on 4-inch nominal-thickness concrete base. Comply with requirements for concrete base specified in Division 03 Section.
 - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
 - 2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 4. Install anchor bolts to elevations required for proper attachment to supported equipment.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- D. Install fuses in each fusible-switch enclosed controller.
- E. Install fuses in control circuits if not factory installed. Comply with requirements in Division 26 Section "Fuses."
- F. Install heaters in thermal overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.
- G. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.
- H. Install power factor correction capacitors. Connect to the line/load side of overload relays. If connected to the load side of overload relays, adjust overload heater sizes to accommodate the reduced motor full-load currents.
- I. Comply with NECA 1.

5.03 IDENTIFICATION

- A. Identify enclosed controllers, components, and control wiring. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each enclosure with engraved nameplate.
 - 3. Label each enclosure-mounted control and pilot device.

5.04 CONTROL WIRING INSTALLATION

- A. Install wiring between enclosed controllers and remote devices. Comply with requirements in Division 26 Section "Control-Voltage Electrical Power Cables."
- B. Bundle, train, and support wiring in enclosures. Use 'Panduit' where possible.
- C. Connect selector switches and other automatic-control selection devices where applicable.
 - 1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switch is in manual-control position.
 - 2. Connect selector switches with enclosed-controller circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

5.05 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each enclosed controller, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- C. Tests and Inspections:
 - 1. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
 - 2. Test insulation resistance for each enclosed-controller element, component, connecting motor supply, feeder, and control circuits.
 - 3. Test continuity of each circuit.
 - 4. Verify that voltages at controller locations are within plus or minus 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Owner before starting the motor(s).
 - 5. Test each motor for proper phase rotation.
 - 6. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 8. Perform the following infrared (thermo graphic) scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each multi-pole enclosed controller. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each multi-pole enclosed controller 11 months after date of Substantial Completion.
 - c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - 9. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Enclosed controllers will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports including a certified report that identifies enclosed controllers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

5.06 ADJUSTING

- A. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.
- B. Adjust overload-relay heaters or settings if power factor correction capacitors are connected to the load side of the overload relays.
- C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable instantaneous trip elements. Initially adjust to six times the motor nameplate full-load ampere ratings and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without

tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Engineer before increasing settings.

- D. Set field-adjustable switches and program microprocessors for required start and stop sequences in reduced-voltage solid-state controllers.

5.07 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until enclosed controllers are ready to be energized and placed into service.
- B. Replace controllers whose interiors have been exposed to water or other liquids prior to Substantial Completion.

5.08 DEMONSTRATION

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

END OF SECTION

PART 1 GENERAL

1.01 REFERENCE STANDARDS

- A. NFPA 780 - Standard for the Installation of Lightning Protection Systems; 2026.
- B. UL 96 - Lightning Protection Components; Current Edition, Including All Revisions.
- C. UL 96A - Standard for Installation Requirements for Lightning Protection Systems; Current Edition, Including All Revisions.

1.02 RELATED DOCUMENTS

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

1.03 SUMMARY

- A. Section includes lightning protection for structures.
- B. This section specifies the lightning protection system for the building(s) or structure(s). This system provides safety for the building and occupants by preventing damage to the structure caused by lightning. The design of this system is to be in strict accordance with this section of the specification and all contract drawings that apply.
- C. The work covered under this section of the specifications consists of furnishing design, labor, materials and services required for the completion of a functional and unobtrusive lightning protection system approved by the architect and engineer.
- D. A specialty contractor actively engaged in the installation of certified lightning protection systems.

1.04 SUBMITTALS

- A. Shop Drawings: For air terminals and mounting accessories.
 - 1. Layout of the lightning protection system, along with details of the components to be used in the installation.
 - 2. Include indications for use of raceway, data on how concealment requirements will be met, and calculations required by NFPA 780 for bonding of grounded and isolated metal bodies.
- B. Qualification Data: For qualified Installer and manufacturer. Include data on listing or certification by UL.
- C. Certification, signed by Contractor, that roof adhesive is approved by manufacturer of roofing material.
- D. Field quality-control reports.
- E. The qualified installer must provide a system which measures no more than 2 ohms resistance.
- F. Comply with recommendations in NFPA 780, Annex D, "Inspection and Maintenance of Lightning Protection Systems," for maintenance of the lightning protection system.
- G. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features, including the following:
 - 1. Ground rods.
 - 2. Ground loop conductor.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: Certified by UL as a Master Installer/Designer, trained and approved for installation of units required for this Project.
- B. System Certificate:
 - 1. UL Master Label.

- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 780, "Definitions" Article.

1.06 COORDINATION

- A. Coordinate installation of lightning protection with installation of other building systems and components, including electrical wiring, supporting structures and building materials, metal bodies requiring bonding to lightning protection components, and building finishes.
- B. Coordinate installation of air terminals attached to roof systems with roofing manufacturer and Installer.
 - 1. Flashings of through-roof assemblies shall comply with roofing manufacturers' specifications.

PART 2 PRODUCTS

2.01 LIGHTNING PROTECTION SYSTEM COMPONENTS

- A. Comply with UL 96 and NFPA 780.
- B. Roof-Mounted Air Terminals: NFPA 780, Class I copper.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
 - a. Advanced Lightning Technology
 - b. Bonded Lightning Protection Systems
 - c. Thompson Lightning Protection
 - 2. Air Terminals More than 24 Inches Long: With brace attached to the terminal at not less than half the height of the terminal.
 - 3. Single-Membrane, Roof-Mounted Air Terminals: Designed specifically for single-membrane roof system materials. Comply with requirements in Division 07 roofing Sections.
- C. Main and Bonding Conductors: #2/0 Copper
- D. Ground Loop Conductor: #2/0 Copper
 - 1. Ground Rods: Copper-clad steel; 3/4 inch (19.05 mm) in diameter by 10 feet (304.8 cm) long.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install lightning protection components and systems according to UL 96A and NFPA 780.
- B. Install conductors with direct paths from air terminals to ground connections. Avoid sharp bends.
- C. Conceal the following conductors:
 - 1. System conductors.
 - 2. Down conductors.
 - 3. Interior conductors.
- D. Cable Connections: Use crimped or bolted connections for all conductor splices and connections between conductors and other components. Use exothermic-welded connections in underground portions of the system.
- E. Cable Connections: Use exothermic-welded connections for all conductor splices and connections between conductors and other components.
- F. Bond extremities of vertical metal bodies exceeding 60 feet (1828.8 cm) in length to lightning protection components.
- G. Ground Loop: Install ground-level, potential equalization #2/0 copper conductor and extend around the perimeter of structure.

1. Bury ground ring not less than 24 inches (609.6 mm) from building foundation.
 2. Bond ground terminals to the ground loop.
 3. Bond grounded building systems to the ground loop conductor within 12 feet (365.76 cm) of grade level.
- H. Bond lightning protection components with intermediate-level interconnection loop conductors to grounded metal bodies of building at 60-foot intervals.
- 3.02 CORROSION PROTECTION
- A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.
 - B. Use conductors with protective coatings where conditions cause deterioration or corrosion of conductors.
- 3.03 FIELD QUALITY CONTROL
- A. Notify Architect at least 48 hours in advance of inspection before concealing lightning protection components.
 - B. UL Inspection: Meet requirements to obtain a UL Master Label for system.
 - C. LPI System Inspection: Meet requirements to obtain an LPI System Certificate.
 - D. Provide and record and submit the testing reports once installation has been completed and certified.

END OF SECTION

26 43 13

SURGE PROTECTION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 GENERAL

3.01 RELATED DOCUMENTS

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

3.02 SUMMARY

- A. Section includes field-mounted SPD's for low-voltage (120 to 600 V) power distribution and control equipment.
- B. Related Sections:
 - 1. Division 26 Section "Switchboards" for factory-installed SPD's.
 - 2. Division 26 Section "Panelboards" for factory-installed SPD's.
 - 3. Division 26 Section "Wiring Devices" for devices with integral SPD's.

3.03 DEFINITIONS

- A. ATS: Acceptance Testing Specifications.
- B. SVR: Suppressed voltage rating.
- C. SPD: Surge Protective Device(s), both singular and plural.

3.04 REFERENCE STANDARDS

- A. IEEE C62.41.2 - IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and less) AC Power Circuits; 2002 (Corrigendum 2012).
- B. NETA ATS - Standard for Acceptance Testing Specifications for Electrical Power Equipment And Systems; 2025.
- C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D. UL 1283 - Standard for Electromagnetic Interference Filters; Current Edition, Including All Revisions.
- E. UL 1449 - Standard for Surge Protective Devices; Current Edition, Including All Revisions.

3.05 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating weights, electrical characteristics, furnished specialties, and accessories.
- B. Qualification Data: For qualified testing agency- (NRTL) National Recognized Testing Laboratory
- C. Product Certificates: For SPD devices, from manufacturer.
- D. Field quality-control reports.
- E. Operation and Maintenance Data: For SPD devices to include in emergency, operation, and maintenance manuals.
- F. Warranties: Sample of special warranties.

3.06 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.
 - 1. Testing Agency's Field Supervisor: Currently certified by NETA or the equipment manufacturer to supervise on-site testing.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency, and marked for intended location and application.

- C. Comply with IEEE C62.41.2 and test devices according to IEEE C62.45.
- D. Comply with UL 1283 and UL 1449 (current edition).
- E. The SPD installation complies with NFPA 70.

3.07 PROJECT CONDITIONS

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

3.08 COORDINATION

- A. Coordinate location of field-mounted SPD devices to allow adequate clearances for maintenance.
- B. Coordinate SPD devices with Division 26 Section "Electrical Power Monitoring and Control."

3.09 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of surge suppressors that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Five (5) years from date of Substantial Completion.

3.10 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Where equipment design uses replaceable protection modules: One (1) of each size and type installed.

PART 2 PRODUCTS

4.01 SERVICE ENTRANCE SUPPRESSORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Square D.
 - 2. GE.
 - 3. Eaton/ Cutler-Hammer.
 - 4. Liebert
 - 5. Current Technology Inc.; Danaher Power Solutions.
 - 6. Leviton
- B. Surge Protection Devices:
 - 1. Comply with UL 1449 (current edition).
 - 2. Modular design.
 - 3. Fuses, rated at 200-kA interrupting capacity.
 - 4. Fabrication using bolted compression lugs for internal wiring.
 - 5. Integral disconnect switch or circuit breaker.
 - 6. Redundant suppression circuits.
 - 7. Arrangement with copper bus bars and for bolted connections to phase buses, neutral bus, and ground bus.
 - 8. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
 - 9. LED indicator lights for power and protection status.
 - 10. Audible alarm, with silencing switch, to indicate when protection has failed.

11. Form-C contacts rated at 1 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
 12. Six-digit transient-event counter set to totalize transient surges.
- C. Surge Current Capacity – The minimum surge current capacity the device is capable of withstanding shall be as shown in the following table:

Minimum surge current capacity based on ANSI / IEEE C62.41 location category			
Category	Application	Per Phase	Per Mode
C	Service Entrance Locations (Switchboards, Switchgear, MCC, Main Entrance)	250 kA	125 kA
B	High Exposure Roof Top Locations (Distribution Panelboards)	160 kA	80 kA
A	Branch Locations (Panelboards, MCCs, Busway)	120 kA	60 kA

- D. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V and 208Y/120 V, 3-phase, 4-wire circuits shall be as follows:
1. Line to Neutral: 1200 V for 480Y/277 V, 700 V for 208Y/120 V.
 2. Line to Ground: 2000 V for 480Y/277 V, 1200 V for 208Y/120 V.
 3. Neutral to Ground: 1200 V for 480Y/277 V, 700 V for 208Y/120 V.

4.02 PANELBOARD SUPPRESSORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Square D.
 2. GE.
 3. Eaton/ Cutler Hammer.
 4. Advanced Protection Technologies Inc. (APT).
 5. Current Technology Inc.
- B. Surge Protection Devices:
1. Non-modular.
 2. LED indicator lights for power and protection status.
 3. Audible alarm, with silencing switch, to indicate when protection has failed.
 4. Form-C contacts rated at 1 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
- C. Surge Current Capacity – The minimum surge current capacity the device is capable of withstanding shall be as shown in the following table:

Minimum surge current capacity based on ANSI / IEEE C62.41 location category			
Category	Application	Per Phase	Per Mode
C	Service Entrance Locations (Switchboards, Switchgear, MCC, Main Entrance)	250 kA	125 kA
B	High Exposure Roof Top Locations (Distribution Panelboards)	160 kA	80 kA
A	Branch Locations (Panelboards, MCCs, Busway)	120 kA	60 kA

- D. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V, 208Y/120 V, 3-phase, 4-wire circuits shall be as follows:
1. Line to Neutral: 1200 V for 480Y/277 V, 700 V for 208Y/120 V.
 2. Line to Ground: 2000 V for 480Y/277 V, 1200 V for 208Y/120 V.
 3. Neutral to Ground: 1200 V for 480Y/277 V, 700 V for 208Y/120 V.

4.03 ENCLOSURES

- A. Indoor Enclosures: NEMA 250 Type 1.
- B. Outdoor Enclosures: NEMA 250 Type 3R.

PART 3 EXECUTION

5.01 INSTALLATION

- A. Install SPD devices at service entrance on load side, with ground lead bonded to service entrance ground.
- B. Install SPD devices for panelboards and auxiliary panels with conductors or buses between suppressor and points of attachment as short and straight as possible. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground at the SPD. Ground only at NEC required locations.
 1. Provide manufacturer's approved circuit breaker as applicable as a dedicated disconnecting means for SPD unless otherwise indicated.

5.02 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
 1. Verify that electrical wiring installation complies with manufacturer's written installation requirements.
- B. Tests and Inspections:
 1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, "Surge Arresters, Low-Voltage Surge Protection Devices" Section. Certify compliance with test parameters.
 2. After installing SPD devices but before electrical circuitry has been energized, test for compliance with requirements.
 3. Complete startup checks according to manufacturer's written instructions.
- C. SPD device will be considered defective if it does not pass tests and inspections.

- D. Prepare test and inspection reports.

5.03 STARTUP SERVICE

- A. Do not energize or connect service entrance equipment, panelboards, control terminals or data terminals to their sources until SPD devices are installed and connected.
- B. Do not perform insulation resistance tests of the distribution wiring equipment with the SPD installed. Disconnect before conducting insulation resistance tests and reconnect immediately after the testing is over.

5.04 DEMONSTRATION

- A. Engage a factory-authorized service representative to train. Owner's maintenance personnel to maintain SPD devices.

END OF SECTION

26 51 00

INTERIOR LIGHTING

PART 1 GENERAL

3.01 RELATED DOCUMENTS

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

3.02 SUMMARY

- A. This Section includes the following:
 - 1. Interior lighting fixtures and drivers.
 - 2. Emergency lighting units.
 - 3. Exit signs LED lighted
 - 4. Lighting fixture supports.
- B. Related Sections include the following:
 - 1. Division 26 Section "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multiple lighting relays and contactors.
 - 2. Division 26 Section "Wiring Devices" for manual wall-box dimmers for incandescent lamps.
 - 3. Division 26 Section "Theatrical Lighting" for theatrical lighting fixtures and their controls.
- C. Submittals:
 - 1. Provide cut-sheets and summary all types of fixtures for review.

3.03 DEFINITIONS

- A. BF: Ballast factor.
- B. CRI: Color-rendering index.
- C. CU: Coefficient of utilization.
- D. LER: Luminaire efficacy rating.
- E. Luminaire: Complete lighting fixture, including ballast housing if provided.
- F. RCR: Room cavity ratio.
- G. LED Light Emitted Diode

3.04 REFERENCE STANDARDS

- A. 29 CFR 1910 - Occupational Safety and Health Standards; Current Edition.
- B. ANSI C82.1 - American National Standard for Lamp Ballasts - Line Frequency Fluorescent Lamp Ballasts; 2004, with Supplement (2020).
- C. ANSI C82.4 - American National Standard for Lamp Ballasts - Ballasts for High-Intensity-Discharge and Low-Pressure Sodium Lamps; 2017, with Editorial Revision (2022).
- D. ANSI C82.11 - American National Standard for Lamp Ballasts - High Frequency Fluorescent Lamp Ballasts; 2023.
- E. ASTM A580/A580M - Standard Specification for Stainless Steel Wire; 2023.
- F. ASTM A641/A641M - Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire; 2019 (Reapproved 2025).
- G. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- H. UL 924 - Emergency Lighting and Power Equipment; Current Edition, Including All Revisions.

- I. UL 1029 - High-Intensity-Discharge Lamp Ballasts; Current Edition, Including All Revisions.
- J. UL 1598 - Luminaires; Current Edition, Including All Revisions.

3.05 SUBMITTALS

- A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
 - 1. Physical description of lighting fixture including dimensions.
 - 2. Emergency lighting units including battery and charger.
 - 3. Ballast.
 - 4. Energy-efficiency data.
 - 5. Air and Thermal Performance Data: For air-handling lighting fixtures. Furnish data required in "Submittals" Article in Division 23 Section "Diffusers, Registers, and Grilles."
 - 6. Sound Performance Data: For air-handling lighting fixtures. Indicate sound power level and sound transmission class in test reports certified according to standards specified in Division 23 Section "Diffusers, Registers, and Grilles."
 - 7. Life, output, and energy-efficiency data for lamps.
 - 8. Photometric data, in IESNA format, based on laboratory tests of each lighting fixture type, outfitted with lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.
 - a. For indicated fixtures, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining fixtures shall be certified by the manufacturer.
 - b. Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program (NVLAP) for Energy Efficient Lighting Products.
- B. Shop Drawings: Show details of nonstandard or custom lighting fixtures. Indicate dimensions, weights, methods of field assembly, components, features, and accessories.
 - 1. Wiring Diagrams: Power and control wiring.
- C. Samples for Verification: Interior lighting fixtures designated for sample submission in Interior Lighting Fixture Schedule. Each sample shall include the following:
 - 1. Lamps: Specified units installed.
 - 2. Accessories: Cords and plugs.
- D. Product Certificates: For each type of ballast for bi-level and dimmer-controlled fixtures, signed by product manufacturer.
- E. Qualification Data: For agencies providing photometric data for lighting fixtures.
- F. Field quality-control test reports.
- G. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.
- H. Warranties: Special warranties specified in this Section.

3.06 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.
- B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7.

- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. Comply with NFPA 70.
- E. FMG Compliance: Lighting fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FMG.
- F. Mockups: Provide interior lighting fixtures for room or module mock-ups, complete with power and control connections.
 - 1. Obtain Architect's approval of fixtures for mockups before starting installations.
 - 2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 - 3. Approved fixtures in mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

3.07 COORDINATION

- A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

3.08 WARRANTY

- A. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Emergency Lighting Unit Batteries: 5 years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining nine years.
 - 2. Warranty Period for Emergency Fluorescent Ballast Batteries: 5 years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining six years.
- B. Special Warranty for Ballasts: Manufacturer's standard form in which ballast manufacturer agrees to repair or replace ballasts that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Electronic Ballasts: Five years from date of Substantial Completion.
 - 2. Warranty Period for Electromagnetic Ballasts: Three years from date of Substantial Completion.
- C. Special Warranty for T5 and T8 Fluorescent Lamps: Manufacturer's standard form, made out to Owner and signed by lamp manufacturer agreeing to replace lamps that fail in materials or workmanship, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.
 - 1. Warranty Period: Two (2) year(s) from date of Substantial Completion.

3.09 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
 - 2. Plastic Diffusers and Lenses: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
 - 3. Battery and Charger Data: One for each emergency lighting unit.

4. Ballasts: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
5. Globes and Guards: 1 for every 20 of each type and rating installed. Furnish at least one of each type.

PART 2 PRODUCTS

4.01 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
- B. In Interior Lighting Fixture Schedule where titles below are column or row headings that introduce lists, the following requirements apply to product selection:
 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
- C. Luminaires, Acceptable Manufacturers:
 1. Philips
 2. Hubbell
 3. Kenall
 4. Lithonia
 5. Cooper

4.02 LIGHTING FIXTURES AND COMPONENTS, GENERAL REQUIREMENTS

- A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.
- B. Incandescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5A.
- C. Fluorescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.
- D. Metal Parts: Free of burrs and sharp corners and edges.
- E. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.
- F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit re-lamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during re-lamping and when secured in operating position.
- G. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:
 1. White Surfaces: 85 percent.
 2. Specular Surfaces: 83 percent.
 3. Diffusing Specular Surfaces: 75 percent.
 4. Laminated Silver Metalized Film: 90 percent.
- H. Plastic Diffusers, Covers, and Globes:
 1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - a. Lens Thickness: At least 0.125 inch (3.18 mm) minimum unless different thickness is indicated.
 - b. UV stabilized.
 2. Glass: Annealed crystal glass, unless otherwise indicated.
- I. Electromagnetic-Interference Filters: Factory installed to suppress conducted electromagnetic-interference as required by MIL-STD-461E. Fabricate lighting fixtures, indicated to require a filter, with one filter per ballast.

- J. Air-Handling Fluorescent Fixtures: For use with plenum ceiling for air return and heat extraction and for attaching an air-diffuser-boot assembly specified in Division 23 Section "Diffusers, Registers, and Grilles."
 - 1. Air Supply Units: Slots in one or both side trims join with air-diffuser-boot assemblies.
 - 2. Heat Removal Units: Air path leads through lamp cavity.
 - 3. Combination Heat Removal and Air Supply Unit: Heat is removed through lamp cavity at both ends of the fixture door with air supply same as for air supply units.
 - 4. Dampers: Operable from outside fixture for control of return-air volume.
 - 5. Static Fixture: Air supply slots are blanked off, and fixture appearance matches active units.

4.03 BALLASTS FOR LINEAR FLUORESCENT LAMPS

- A. Electronic Ballasts: Comply with ANSI C82.11; instant-start type, unless otherwise indicated, and designed for type and quantity of lamps served. Ballasts shall be designed for full light output unless dimmer or bi-level control is indicated.
 - 1. Sound Rating: A.
 - 2. Total Harmonic Distortion Rating: Less than 10 percent.
 - 3. Transient Voltage Protection: IEEE C62.41, Category A or better.
 - 4. Operating Frequency: 20 kHz or higher.
 - 5. Lamp Current Crest Factor: 1.7 or less.
 - 6. BF: 0.88 or higher.
 - 7. Power Factor: 0.95 or higher.
 - 8. Parallel Lamp Circuits: Multiple lamp ballasts shall comply with ANSI C82.11 and shall be connected to maintain full light output on surviving lamps if one or more lamps fail.
- B. Electronic Programmed-Start Ballasts for T5 Lamps: Comply with ANSI C82.11 and the following:
 - 1. Lamp end-of-life detection and shutdown circuit for T5 diameter lamps.
 - 2. Automatic lamp starting after lamp replacement.
 - 3. Sound Rating: A.
 - 4. Total Harmonic Distortion Rating: Less than 20 percent.
 - 5. Transient Voltage Protection: IEEE C62.41, Category A or better.
 - 6. Operating Frequency: 20 kHz or higher.
 - 7. Lamp Current Crest Factor: 1.7 or less.
 - 8. BF: 0.95 or higher, unless otherwise indicated.
 - 9. Power Factor: 0.95 or higher.
- C. Electromagnetic Ballasts: Comply with ANSI C82.1; energy saving, high-power factor, Class P, and having automatic-reset thermal protection.
 - 1. Ballast Manufacturer Certification: Indicated by label.
- D. Ballasts for Low-Temperature Environments:
 - 1. Temperatures 0 Deg F and Higher: Electronic or electromagnetic type rated for 0 deg F starting and operating temperature with indicated lamp types.
- E. Ballasts for Low Electromagnetic-Interference Environments: Comply with 47 CFR, Chapter 1, Part 18, Subpart C, for limitations on electromagnetic and radio-frequency interference for consumer equipment.
- F. Ballasts for Dimmer-Controlled Lighting Fixtures: Electronic type.
 - 1. Dimming Range: 100 to 5 percent of rated lamp lumens.
 - 2. Ballast Input Watts: Can be reduced to 20 percent of normal.
 - 3. Compatibility: Certified by manufacturer for use with specific dimming control system and lamp type indicated.
- G. Ballasts for Bi-Level Controlled Lighting Fixtures: Electronic type.

1. Operating Modes: Ballast circuit and leads provide for remote control of the light output of the associated lamp between high- and low-level and off.
 - a. High-Level Operation: 100 percent of rated lamp lumens.
 - b. Low-Level Operation: 30 percent of rated lamp lumens.
2. Ballast shall provide equal current to each lamp in each operating mode.
3. Compatibility: Certified by manufacturer for use with specific bi-level control system and lamp type indicated.

4.04 BALLASTS FOR COMPACT FLUORESCENT LAMPS

- A. Description: Electronic programmed rapid-start type, complying with ANSI C82.11, designed for type and quantity of lamps indicated. Ballast shall be designed for full light output unless dimmer or bi-level control is indicated:
 1. Lamp end-of-life detection and shutdown circuit.
 2. Automatic lamp starting after lamp replacement.
 3. Sound Rating: A.
 4. Total Harmonic Distortion Rating: Less than 20 percent.
 5. Transient Voltage Protection: IEEE C62.41, Category A or better.
 6. Operating Frequency: 20 kHz or higher.
 7. Lamp Current Crest Factor: 1.7 or less.
 8. BF: 0.95 or higher, unless otherwise indicated.
 9. Power Factor: 0.95 or higher.
 10. Interference: Comply with 47 CFR, Chapter 1, Part 18, Subpart C, for limitations on electromagnetic and radio-frequency interference for non-consumer equipment.
 11. Ballast Case Temperature: 75 deg C, maximum.
- B. Ballasts for Dimmer-Controlled Lighting Fixtures: Electronic type.
 1. Dimming Range: 100 to 5 percent of rated lamp lumens.
 2. Ballast Input Watts: Can be reduced to 20 percent of normal.
 3. Compatibility: Certified by manufacturer for use with specific dimming control system and lamp type indicated.

4.05 EMERGENCY FLUORESCENT POWER UNIT

- A. Internal Type: Self-contained, modular, battery-inverter unit, factory mounted within lighting fixture body and compatible with ballast. Comply with UL 924.
 1. Emergency Connection: Operate 1 fluorescent lamp(s) continuously at an output of 1100 lumens each. Connect un-switched circuit to battery-inverter unit and switched circuit to fixture ballast.
 2. Night-Light Connection: Operate one fluorescent lamp continuously.
 3. Test Push Button and Indicator Light: Visible and accessible without opening fixture or entering ceiling space.
 - a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 4. Battery: Sealed, maintenance-free, nickel-cadmium type.
 5. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
 6. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.

7. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

4.06 BALLASTS FOR HID LAMPS

- A. Electromagnetic Ballast for Metal-Halide Lamps: Comply with ANSI C82.4 and UL 1029. Include the following features, unless otherwise indicated:
 1. Ballast Circuit: Constant-wattage autotransformer or regulating high-power-factor type.
 2. Minimum Starting Temperature: Minus 22 deg F for single-lamp ballasts.
 3. Normal Ambient Operating Temperature: 104 deg F.
 4. Open-circuit operation that will not reduce average life.
 5. Low-Noise Ballasts: Manufacturers' standard epoxy-encapsulated models designed to minimize audible fixture noise.
- B. Electronic Ballast for Metal-Halide Lamps: Include the following features unless otherwise indicated:
 1. Lamp end-of-life detection and shutdown circuit.
 2. Sound Rating: A.
 3. Total Harmonic Distortion Rating: Less than 15 percent.
 4. Transient Voltage Protection: IEEE C62.41, Category A or better.
 5. Lamp Current Crest Factor: 1.5 or less.
 6. Power Factor: .90 or higher.
 7. Interference: Comply with 47 CFR, Chapter 1, Part 18, Subpart C, for limitations on electromagnetic and radio-frequency interference for non-consumer equipment.
 8. Protection: Class P thermal cutout.
 9. Retain subparagraph and associated subparagraphs below for bi-level ballasts.
 10. Bi-Level Dimming Ballast: Ballast circuit and leads provide for remote control of the light output of the associated fixture between high- and low-level and off.
 - a. High-Level Operation: 100 percent of rated lamp lumens.
 - b. Low-Level Operation: 35 percent of rated lamp lumens.
 - c. Compatibility: Certified by ballast manufacturer for use with specific bi-level control system and lamp type indicated. Certified by lamp manufacturer that ballast operating modes are free from negative effect on lamp life and color-rendering capability.
 11. Continuous Dimming Ballast: Dimming range shall be from 100 to 35 percent of rated lamp lumens without flicker.
 - a. Ballast Input Watts: Reduced to a maximum of 50 percent of normal at lowest dimming setting.
 - b. Compatibility: Certified by manufacturer for use with specific dimming control system and lamp type indicated. Certified by lamp manufacturer that ballast operating modes are free from negative effect on lamp life and color-rendering capability.
- C. Auxiliary Instant-On Quartz System: Factory-installed feature automatically switches quartz lamp on when fixture is initially energized and when power outages occur. System automatically turns quartz lamp off when HID lamp reaches approximately 60 percent light output.
- D. High-Pressure Sodium Ballasts: Electromagnetic type, with solid-state igniter/starter. Igniter-starter shall have an average life in pulsing mode of 10,000 hours at an igniter/starter-case temperature of 90 deg C.
 1. Instant Re-strike Device: Integral with ballast, or solid-state potted module, factory installed within fixture and compatible with lamps, ballasts, and mogul sockets up to 150 W.
 - a. Re-strike Range: 105- to 130-V ac.

- b. Maximum Voltage: 250-V peak or 150-V ac RMS.
- 2. Minimum Starting Temperature: Minus 40 degrees Fahrenheit (4.44 degrees Celsius).
- 3. Open-circuit operation shall not reduce average lamp life.

4.07 EXIT SIGNS LED LIGHTED

- A. Description: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Internally Lighted Signs:
 - 1. Lamps for AC Operation: Fluorescent, 2 for each fixture, 20,000 hours of rated lamp life.
 - 2. Lamps for AC Operation: LEDs, 70,000 hours minimum rated lamp life.
 - 3. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
 - a. Battery: Sealed, maintenance-free, nickel-cadmium type.
 - b. Charger: Fully automatic, solid-state type with sealed transfer relay.
 - c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 - d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 - f. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
 - g. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.
 - 4. Master/Remote Sign Configurations:
 - a. Master Unit: Comply with requirements above for self-powered exit signs, and provide additional capacity in LED power supply for power connection to remote unit.
 - b. Remote Unit: Comply with requirements above for self-powered exit signs, except omit power supply, battery and test features. Arrange to receive full power requirements from master unit. Connect for testing concurrently with master unit as a unified system.

4.08 EMERGENCY LIGHTING UNITS

- A. Description: Self-contained units complying with UL 924.
 - 1. Battery: Sealed, maintenance-free, lead-acid type.
 - 2. Charger: Fully automatic, solid-state type with sealed transfer relay.
 - 3. Operation: Relay automatically turns lamp on when power supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 - 4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - 5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 - 6. Wire Guard: Heavy-chrome-plated wire guard protects lamp heads or fixtures.

7. Integral Time-Delay Relay: Holds unit on for fixed interval of 5 minutes when power is restored after an outage.
8. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
9. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

4.09 LIGHTING FIXTURE SUPPORT COMPONENTS

- A. Comply with Division 26 Section "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.
- C. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.
- D. Wires: ASTM A641/A641M, Class 3, soft temper, zinc-coated steel, 12 gage.
- E. Wires for Humid Spaces: ASTM A580/A580M, Composition 302 or 304, annealed stainless steel, 12 gage.
- F. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
- G. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

PART 3 EXECUTION

5.01 INSTALLATION

- A. Lighting fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.
- B. Support for Lighting Fixtures in or on Grid-Type Suspended Ceilings: Use grid as a support element.
 1. Install a minimum of four ceiling support system rods or wires for each fixture. Locate not more than 6 inches (152.4 mm) from lighting fixture corners.
 2. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
 3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.
 4. Install at least four independent support rod or wire from BUILDING structure to a tab on lighting fixture. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.
- C. Suspended Lighting Fixture Support:
 1. Pendants and Rods: Where longer than 48 inches (1219.2 mm), brace to limit swinging.
 2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
 3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.
- D. Air-Handling Lighting Fixtures: Install with dampers closed and ready for adjustment.
- E. Adjust aim-able lighting fixtures to provide required light intensities.
- F. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

5.02 FIELD QUALITY CONTROL

- A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.
- B. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

5.03 CLEANING

- A. Clean the diffuser or lenses before installing to the fixture.

END OF SECTION

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. This Section includes the following:
 - 1. Exterior luminaires with lamps and ballasts.
 - 2. Luminaire-mounted photoelectric relays.
 - 3. Poles and accessories.
- B. Related Sections include the following:
 - 1. List below only products that the reader might expect to find in this Section but are specified elsewhere.
 - 2. Division 26 Section "Interior Lighting" for exterior luminaires normally mounted on exterior surfaces of buildings.

1.03 DEFINITIONS

- A. Retain abbreviations and terms that remain after this Section has been edited.
- B. CRI: Color-rendering index.
- C. LED: Light Emitting Diode.
- D. Luminaire: Complete lighting fixture, including ballast housing if provided.
- E. Pole: Luminaire support structure, including tower used for large area illumination.
- F. Standard: Same definition as "Pole" above.

1.04 REFERENCE STANDARDS

- A. AAMA 611 - Specification for Anodized Architectural Aluminum; 2026.
- B. AASHTO LTS - Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals; 2013, with Editorial Revision (2025).
- C. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.
- D. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2024.
- E. IEEE C2 - National Electrical Safety Code(R) (NESC(R)); 2023.
- F. IESNA RP-8 - Roadway Lighting; 2014.
- G. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- H. SSPC-SP 1 - Solvent Cleaning; 2015, with Editorial Revision (2016).
- I. SSPC-SP 5/NACE No.1 - White Metal Blast Cleaning; 2026.
- J. UL 773 - Plug-in, Locking Type Photocontrols for Use with Area Lighting; Current Edition, Including All Revisions.
- K. UL 773A - Nonindustrial Photoelectric Switches for Lighting Control; Current Edition, Including All Revisions.
- L. UL 1598 - Luminaires; Current Edition, Including All Revisions.

1.05 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

- A. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-.

- B. Live Load: Single load of 500 lbf, distributed as stated in AASHTO LTS-4.
- C. Ice Load: Load of 3 lbf/sq. ft. applied as stated in AASHTO LTS-4.
- D. Wind Load: Pressure of wind on pole and luminaire, calculated and applied as stated in AASHTO LTS-4.
 - 1. Wind speed for calculating wind load for poles 50 feet (1524 cm) or less in height is 110 mph.

1.06 SUBMITTALS

- A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:
 - 1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.
 - 2. Details of attaching luminaries and accessories.
 - 3. Details of installation and construction.
 - 4. Luminaire materials.
 - 5. Photometric data based on laboratory tests of each luminaire type, complete with indicated lamps, ballasts, and accessories.
 - a. For indicated luminaries, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining luminaries shall be certified by manufacturer.
 - b. Photometric data shall be certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
 - 6. Photoelectric relays (photocell).
 - 7. Ballasts, including energy-efficiency data.
 - 8. Lamps, including life, output, and energy-efficiency data.
 - 9. Materials, dimensions, and finishes of poles.
 - 10. Means of attaching luminaries to supports, and indication that attachment is suitable for components involved.
 - 11. Anchor bolts for poles.
 - 12. Retain subparagraph below if manufactured pole foundations, including screw foundations, are indicated.
 - 13. Manufactured pole foundations.
- B. Shop Drawings:
 - 1. Anchor-bolt templates keyed to specific poles and certified by manufacturer.
 - 2. Design calculations, certified by a qualified professional engineer, indicating strength of screw foundations and soil conditions on which they are based.
 - 3. Wiring Diagrams: Power and control wiring.
- C. Samples for Verification: For products designated for sample submission in Exterior Lighting Device Schedule. Each sample shall include lamps and ballasts.
- D. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements in AASHTO LTS-4 and that load imposed by luminaire has been included in design.
- E. Qualification Data: For agencies providing photometric data for lighting fixtures.
- F. Field quality-control test reports.
- G. Operation and Maintenance Data: For luminaries and poles to include in emergency, operation, and maintenance manuals.
- H. Warranty: Special warranty specified in this Section.

1.07 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with IEEE C2, "National Electrical Safety Code."
- D. Comply with NFPA 70.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Package aluminum poles for shipping according to ASTM B 660.
- B. Store poles on decay-resistant-treated skids at least 12 inches (304.8 mm) above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.
- C. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

1.09 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.
 - 1. Warranty Period for Luminaries: Five years from date of Substantial Completion.
 - 2. Warranty Period for Metal Corrosion: Five years from date of Substantial Completion.
 - 3. Warranty Period for Color Retention: Five years from date of Substantial Completion.
 - 4. Warranty Period for Lamps: Replace lamps and fuses that fail within 12 months from date of Substantial Completion; furnish replacement lamps and fuses that fail within the second 12 months from date of Substantial Completion.
 - 5. Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less than three years from date of Substantial Completion.

1.10 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
 - 2. Glass and Plastic Lenses, Covers, and Other Optical Parts: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
 - 3. Ballasts: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
 - 4. Globes and Guards: 10 for every 20 of each type and rating installed. Furnish at least one of each type.
 - 5. At a minimum, the electrical contractor shall provide two (2) cases of fluorescent lamps and one (1) case of electronic ballasts with other attic stock items upon project completion

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Approved Manufacturers: The following manufacturers and their subsidiaries are approved:
 - 1. Phillips / Signify

2. Eaton
 3. Acuity
 4. Hubbell
- B. Substitutions:
1. Procedure as indicated in 26 05 00-1.3(B)
- C. Contractor shall furnish full photometric calculation study for all affected areas for fixtures other than basis-of-design as indicated on Drawings.

2.02 LUMINAIRES, GENERAL REQUIREMENTS

- A. Refer to Drawings for basis-of-design Light Fixture Schedule for all characteristics.
- B. Luminaries shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.
- C. Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaries.
- D. Metal Parts: Free of burrs and sharp corners and edges.
- E. Sheet Metal Components: Corrosion-resistant aluminum, unless otherwise indicated. Form and support to prevent warping and sagging.
- F. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaries.
- G. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit re-lamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during re-lamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.
- H. Exposed Hardware Material: Stainless steel.
- I. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
- J. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.
- K. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:
 1. White Surfaces: 85 percent.
 2. Specular Surfaces: 83 percent.
 3. Diffusing Specular Surfaces: 75 percent.
- L. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
- M. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.
- N. Factory-Applied Finish for Steel Luminaries: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No.1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
 2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.

3. Retain one of three subparagraphs below.
 - a. Color: As selected by Architect from manufacturer's full range.
- O. Factory-Applied Finish for Aluminum Luminaries: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
 2. Retain one of three subparagraphs and associated subparagraph below or revise to suit Project.
 3. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.
 4. Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0 inch (0.02 mm) or thicker) complying with AAMA 611.
 5. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0 inch (0.02 mm) or thicker) complying with AAMA 611.
 - a. Color: Dark bronze.

2.03 LUMINAIRE-MOUNTED PHOTOELECTRIC RELAYS (PHOTOCELLS)

- A. Comply with UL 773 or UL 773A.
- B. Parking lot lights shall be controlled by photo cells or the Building Automation System.
- C. Contact Relays: Factory mounted, single throw, designed to fail in the on position, and factory set to turn light unit on at 1.5 to 3 fc and off at 4.5 to 10 fc with 15-second minimum time delay.
 1. Relay with locking-type receptacle shall comply with NEMA C136.10.
 2. Adjustable window slide for adjusting on-off set points.

2.04 POLES AND SUPPORT COMPONENTS, GENERAL REQUIREMENTS

- A. Structural Characteristics: Comply with AASHTO LTS-4.
 1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in Part 1 "Structural Analysis Criteria for Pole Selection" Article, with a gust factor of 1.3.
 2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaries and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.
- B. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts, unless otherwise indicated.
- C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.
 1. Materials: Shall not cause galvanic action at contact points.
 2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication, unless stainless-steel items are indicated.
 3. Anchor-Bolt Template: Plywood or steel.
- D. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete."
- E. Power-Installed Screw Foundations: Factory fabricated by pole manufacturer, with structural steel complying with ASTM A36/A36M and hot-dip galvanized according to ASTM

A123/A123M; and with top-plate and mounting bolts to match pole base flange and strength required to support pole, luminaire, and accessories.

- F. Breakaway Supports: Frangible breakaway supports, tested by an independent testing agency acceptable to authorities having jurisdiction, according to AASHTO LTS-4.

2.05 STEEL POLES

- A. Poles: Comply with ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psig (317158.96 kPa); 1-piece construction up to 40 feet (1219.2 cm) in height with access hand-hole in pole wall.
1. Shape: Square, tapered.
 2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.
 3. Minimum Tubing Thickness: 7 gauge.
- B. Steel Mast Arms: Single-arm type, continuously welded to pole attachment plate. Material and finish same as pole. Quantity and orientation as indicated on Drawings.
- C. Brackets for Luminaries: Detachable, cantilever, without under-brace.
1. Adapter fitting welded to pole and bracket, then bolted together with stainless-steel bolts.
 2. Cross Section: Tapered oval, with straight tubular end section to accommodate luminaire.
 3. Match pole material and finish.
- D. Pole-Top Tenons: Fabricated to support luminaire or luminaries and brackets indicated, and securely fastened to pole top.
- E. Intermediate Hand-hole and Cable Support: Weather-tight, hand-hole located at midpoint of pole with cover for access to internal welded attachment lug for electric cable support grip.
- F. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through hand-hole.
- G. Cable Support Grip: Wire-mesh type with rotating attachment eye, sized for diameter of cable and rated for a minimum load equal to weight of supported cable times a 5.0 safety factor.
- H. Platform for Lamp and Ballast Servicing: Factory fabricated of steel with finish matching that of pole.
- I. Prime-Coat Finish: Manufacturer's standard prime-coat finish ready for field painting.
- J. Galvanized Finish: After fabrication, hot-dip galvanize complying with ASTM A123/A123M.
- K. Factory-Painted Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No.1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
 2. Interior Surfaces of Pole: One coat of bituminous paint, or otherwise treat for equal corrosion protection.
 3. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
 - a. Color: As indicated by manufacturer's designations

PART 3 EXECUTION

3.01 LUMINAIRE INSTALLATION

- A. Install lamps in each luminaire.

- B. Fasten luminaire to indicated structural supports.
 - 1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.
- C. Adjust luminaries that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources.

3.02 POLE INSTALLATION

- A. Align pole foundations and poles for optimum directional alignment of luminaries and their mounting provisions on the pole.
- B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features, unless otherwise indicated on Drawings:
 - 1. Fire Hydrants and Storm Drainage Piping: 60 inches (1524 mm).
 - 2. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet (304.8 cm).
 - 3. Trees: 15 feet (457.2 cm).
- C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Division 03 Section "Cast-in-Place Concrete."
- D. Foundation-Mounted Poles: Mount pole with leveling nuts and tighten top nuts to torque level recommended by pole manufacturer.
 - 1. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.
 - 2. Grout void between pole base and foundation. Use non-shrink or expanding concrete grout firmly packed to fill space.
 - 3. Install base covers, unless otherwise indicated.
 - 4. Use a short piece of 1/2-inch-diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.
- E. Embedded Poles with Tamped Earth Backfill: Set poles to depth below finished grade indicated on Drawings, but not less than one-sixth of pole height.
 - 1. Dig holes large enough to permit use of tampers in the full depth of hole.
 - 2. Backfill in 6-inch layers and thoroughly tamp each layer so compaction of backfill is equal to or greater than that of undisturbed earth.
- F. Embedded Poles with Concrete Backfill: Set poles in augured holes to depth below finished grade indicated on Drawings, but not less than one-sixth of pole height.
 - 1. Make holes 6 inches (152.4 mm) in diameter larger than pole diameter.
 - 2. Fill augured hole around pole with air-entrained concrete having a minimum compressive strength of 3000 psi (20684.28 kPa) at 28 days, and finish in a dome above finished grade.
 - 3. Use a short piece of 1/2-inch- diameter pipe to make a drain hole through concrete dome. Arrange to drain condensation from interior of pole.
 - 4. Cure concrete a minimum of 72 hours before performing work on pole.
- G. Poles and Pole Foundations Set in Concrete Paved Areas: Install poles with minimum of 6-inch- wide, unpaved gap between the pole or pole foundation and the edge of adjacent concrete slab. Fill unpaved ring with pea gravel to a level 1 inch (25.4 mm) below top of concrete slab.
- H. Raise and set poles using web fabric slings (not chain or cable).

3.03 BOLLARD LUMINAIRE INSTALLATION

- A. Align units for optimum directional alignment of light distribution.
- B. Install on concrete base with top 4 inches (101.6 mm) above finished grade or surface at bollard location. Cast conduit into base, and shape base to match shape of bollard base.

Finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 03 Section "Cast-in-Place Concrete."

3.04 INSTALLATION OF INDIVIDUAL GROUND-MOUNTING LUMINAIRES

- A. Install on concrete base with top 4 inches (101.6 mm) above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 03 Section "Cast-in-Place Concrete."

3.05 CORROSION PREVENTION

- A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.
- B. Steel Conduits: Comply with Division 26 Section "Raceway and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch-thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.06 GROUNDING

- A. Ground metal poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."
 - 1. Install grounding electrode for each pole, unless otherwise indicated.
 - 2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

3.07 FIELD QUALITY CONTROL

- A. Inspect each installed fixture for damage. Replace damaged fixtures and components.
- B. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.
 - 1. Verify operation of photoelectric controls.
- C. Illumination Tests:
 - 1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IESNA testing guide(s):
 - a. IESNA LM-5, "Photometric Measurements of Area and Sports Lighting."
 - b. IESNA LM-50, "Photometric Measurements of Roadway Lighting Installations."
 - c. IESNA LM-52, "Photometric Measurements of Roadway Sign Installations."
 - d. IESNA LM-64, "Photometric Measurements of Parking Areas."
 - e. IESNA LM-72, "Directional Positioning of Photometric Data."
- D. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.08 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain luminaire lowering devices. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Requirements of Division 26 "COMMON WORK RESULTS FOR ELECTRICAL" apply to this Section.

1.02 SECTION INCLUDES

- A. Cabinets.
- B. Relays/Contactors.
- C. Photo cells.
- D. Time clocks.
- E. Power supplies.
- F. Terminal blocks.
- G. Plastic wiring troughs.
- H. Miscellaneous.

1.03 REFERENCE STANDARDS

- A. NEMA ICS 2 - Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts; 2008 (Reaffirmed 2020).
- B. NEMA ICS 4 - Application Guideline for Terminal Blocks; 2015.
- C. UL 508 - Industrial Control Equipment; Current Edition, Including All Revisions.
- D. UL 773A - Nonindustrial Photoelectric Switches for Lighting Control; Current Edition, Including All Revisions.
- E. UL 917 - Clock-Operated Switches; Current Edition, Including All Revisions.

1.04 SUBMITTALS: SUBMIT THE FOLLOWING IN ACCORDANCE WITH SECTION 260500.

- A. Shop Drawings: Provide complete point to point wiring diagrams inside low voltage panels and from panels to control/switching sources. Provide shop drawings indicating all conduit sizes and locations required for switching system.
- B. Product Data: Provide for each device specified. Indicate coil and contact ratings, dimensions, cabinets and accessory items.
- C. Provide category and UL file number for products.
- D. Warranties.
- E. Submittals for this section shall be signed by the subcontractor responsible for Division 13 controls, also.

PART 2 PRODUCTS

2.01 CABINETS

- A. Factory mount relays, time clocks, power supplies, terminal blocks, wiring troughs and accessories in a NEMA 1 cabinet conforming to Section 260533 RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS by a UL 508 listed manufacturer unless otherwise directed.
- B. Contactors/relays shall be individually identified with name tags. All wiring within cabinets shall be pre wired through plastic wiring troughs and brought to terminal blocks for field connections. Wires at terminal blocks and contactors/relays shall be identified by contactor/relay and pole number.
- C. Low voltage control wiring shall conform to Section 260519 LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES 600V wires and cables.

- D. Provide 1/4" minimum spacing between non-power limited wiring and power limited wiring.
- E. Cabinet and components shall be suitable for installation and operation in an unconditioned space.
- F. Relay cabinet power shall be 120 volts or as otherwise indicated.
- G. Cabinets shall be lockable, keyed alike. Furnish two (2) keys for each cabinet.
- H. Provide wire bending space, clearances, construction, etc. in accordance with NEC-312.

2.02 RELAYS/CONTACTORS

- A. Provide mechanically held SPST Class A150 contacts of required number, voltage, and current rating conforming to NEMA ICS 2 and UL 508 "industrial control equipment." Contacts shall be fully field convertible from N.O. to N.C.
 - 1. Magnetic Control Relay: Class A300.
 - 2. Time Delay Relay: Class A600.
- B. Control coil shall be Class 2 power limited with solid state control accessories as required.
- C. Line and low voltage terminals shall be screw type.
- D. Relays shall be ASCO 917 with 47, 48 or 49 Series control modules as required or equal by General Electric, Square D, Westinghouse/Cutler-Hammer, Siemens/ITE

2.03 PHOTO CELLS

- A. Photocell switch manufactured to NEMA ICS 2 and UL 773A "Non-industrial Photoelectric Switches for Lighting Control."
- B. Provide voltage, NEMA rating, contact rating and contact configuration as required.
- C. Sensitivity two (2) footcandles to 50 footcandles, adjustable.
- D. Provide photo cells manufactured by Intermatic, Dayton, Paragon or Tork.

2.04 TIME CLOCKS

- A. Provide 24 hour clock timer manufactured to NEMA ICS 2 and UL 917 "Clock Operated Switches" with two (2) astronomic time setting and 12 hour spring wound reserve power carry over.
- B. Manufacturers: Intermatic, Dayton, Paragon, Tork.

2.05 POWER SUPPLY

- A. Provide low voltage power supply in conformance with NEC Article 725 Class 2 and UL 1585 "Class 2 and Class 3 Transformers."
- B. Provide transformer size, primary, secondary fusing and accessories as required.
- C. Manufacturers: General Electric, Square D, Westinghouse, Dormeyer, White Rodgers.

2.06 TERMINAL BLOCKS

- A. Conform to NEMA ICS 4 and UL 486A "Wire Connectors and Soldering Lugs for use with Copper Conductors."
- B. Provide phenolic, channel mount, screw type terminals.
- C. Manufacturers: General Electric, Square D, Westinghouse, Cutler/Hammer, Buchanan, Allen-Bradley, Entelec, Pass & Seymour/Legrand, Thomas and Betts, Marathon, Ilasco.
- D. Provide UL listed copper ground terminal.

2.07 PLASTIC WIRING TROUGHS

- A. Provide open slot vinyl wiring duct with snap on cover conforming to NEMA ICS 6 of width and height as required.

- B. Manufacturers: Gould Shawmut, Panduit, Rob Roy, Tyton, Electrovert, Pass & Seymour/Legrand, Leviton.

2.08 MISCELLANEOUS

- A. Provide miscellaneous items (diodes, solid state relays, logic chips, fuse holders, etc.) as required for a complete operating system.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Furnish all labor, materials, tools, equipment, and services for interface with HVAC controls, lighting controls, and other control systems as indicated and required by contract documents. Relays, conduit, wiring and accessories required shall be provided and installed.
- B. Completely coordinate with work of all other trades.
- C. Although such work is not specifically indicated, furnish and install all supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for a sound, secure and complete installation.
- D. Mount control panels where indicated on drawings and provide proper NEC working clearance assuming panel will require examination while energized.
- E. Use manufacturer's recommended cable size for length of run and relays served.
- F. Provide conduit and wire between control panels, power panels, relays and low voltage switches as required to achieve the sequence of operation indicated.
- G. Inside relay cabinets, provide 1/4" minimum spacing between non-power limited wiring and power limited wiring. Otherwise, power limited wiring shall be in separate enclosures from non-power limited wiring.

3.02 DEMONSTRATION

- A. Provide system demonstration under provisions of contract closeout.

END OF SECTION

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Requirements of Division 26 "COMMON WORK RESULTS FOR ELECTRICAL" apply to this Section.

1.02 SECTION INCLUDES

- A. Testing by Installing Contractor
- B. Testing by Independent Certified Testing Contractor
- C. All testing shall be witness with the Owner, Commissioning Agent, Engineer or Architect.

1.03 SUBMITTALS: SUBMIT THE FOLLOWING IN ACCORDANCE WITH SECTION 260500.

- A. Contractor shall submit experience and certified of testing firm and individuals who will be performing and evaluating tests before any tests are done.
- B. Contractor shall submit in writing at least 24 hours in advance notification of the occurrence of any test described in this section.
- C. Contractor shall record all test data and submit three (3) copies for review. In addition to the test data, each record shall include; date of test, ambient temperature, climate conditions, instruments used, names of test personnel and witnesses and identification of items tested.
- D. The testing firm shall maintain a written record of all tests and, upon completion of project, shall assemble and certify a final test report.

1.04 QUALITY ASSURANCE: COMPLY WITH THE FOLLOWING.

- A. All tests shall be done in accordance with all applicable codes and standards.
- B. Qualifications of Testing Firm:
 - 1. The testing firm shall be an independent testing organization which can function as an unbiased testing authority, professionally independent of the manufacturers, suppliers, and installers of equipment or systems evaluated by the testing firm.
 - 2. The testing firm shall be regularly engaged in the testing of electrical equipment devices, installations, and systems.
 - 3. The testing firm shall meet OSHA criteria for accreditation of testing laboratories, Title 29, or be a Full Member company of the International Electrical Testing Association (IETA).
 - 4. The testing firm shall utilize engineers and technicians who are regularly employed by the firm for testing services.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 DIVISION OF RESPONSIBILITY

- A. All tests indicate in this specification section shall be done by the testing firm except the installing contractor shall be responsible for the following:
 - 1. The contractor shall perform routine insulation-resistance, continuity, and rotation tests for all distribution and utilization equipment prior to and in addition to tests performed by the testing firm specified herein.
 - 2. 120 Volt General Purpose Receptacles: All 120 volt general purpose receptacles shall be tested for correct connection using a Hubbell Catalog #5200 or equal receptacle tester.
 - 3. 120 Volt Ground Fault Circuit, Interrupter (GFCI) Receptacles: All 120 volt GFCI receptacles shall be tested for correct connection and rating using Hubbell Catalog #GFT-2G with a range of 2 to 7 milliamps.
 - 4. Enclosed (Disconnect) Switches: Subsequently to completion of installation of electrical disconnect switches, energize circuits and demonstrate capability and compliance with requirements. Except as otherwise indicated, do not test switches by operating them

under load. However, demonstrate switch operation through six opening/closing cycles with circuit unloaded. Open each switch enclosure for inspection of interior, mechanical and electrical connections, fuse installation, and for verification of type and rating of fuses installed. Correct deficiencies then retest to demonstrate compliance. Remove and replace defective units with new units and retest.

5. Light Switching: Verify proper connection and operation of switches for lighting fixtures.
6. Lighting Contactors: Demonstrate proper operation of lighting contactors for all items indicated in Division 16.
7. Balancing Loads: After Substantial Completion, but not more than two months after Final Acceptance, conduct load-balancing measurements on panelboards and circuit changes as follows:
 - a. Perform measurements during period of normal working load as advised by the Owner.
 - b. Perform load-balancing circuit changes outside the normal occupancy/working schedule of the facility. Make special arrangements with Owner to avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
 - c. Recheck loads after circuit changes during normal load period. Record all load readings before and after changes and submit test records.
 - d. Tolerance: Difference between phase loads exceeding 20 percent at any one panelboard is not acceptable. Rebalance and recheck as required to meet this minimum requirement.
- B. The Contractor shall supply a suitable and stable source of electrical power to each test site. The testing firm shall specify the specific power requirements.
- C. The Contractor shall notify the testing firm when equipment becomes available for acceptance tests. Work shall be coordinated to expedite project scheduling.
- D. Any system, material, or workmanship which is found defective on the basis of acceptance tests shall be reported to the Owner/Engineer's representative replaced or repaired by the Contractor at no cost to the Owner, and retested.
- E. An electrical system will not be accepted until tested in its entirety and results reported to the Owner.

3.02 TESTING FIRM

- A. The testing firm shall test the following equipment as indicated in each section:
 1. 600V Wire and Cables
 2. Grounding and Bonding.
 3. Dry Type Transformers.
 4. Enclosed Motor Controllers
 5. Motor Control Center
 6. Panelboards
 7. Switchboards/Switchgear

3.03 INFRARED BASELINE SCANNING

- A. Provide scanning for Switchboards, Transformers, MCC's, Panelboards, Generator connection points, Copper Busses, Circuit Breakers, Terminations and Transfer Switches.
- B. After Substantial Completion, but not more than two (2) months after Final Acceptance, perform an infrared IR scan in Section 26-95-00 Part 3, 3.2 of each panelboard, switchboard and pad mounted transformer. Remove fronts to make joints and connections accessible to a portable scanner.
- C. Instrument: Use an approved infrared IR scanning device designed to measure temperature or detect significant deviations from normal values. Provide calibration record for device used.

- D. Record of Infrared IR Scanning: Prepare a certified report identifying panelboards checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION

28 31 01

FIRE ALARM AND SMOKE DETECTION SYSTEM

PART 1 GENERAL

3.01 REFERENCE STANDARDS

- A. ANSI 117 - Standard Specification for Structural Glued Laminated Timber of Softwood Species; 2025.
- B. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- C. NFPA 72 - National Fire Alarm and Signaling Code; Most Recent Edition Cited by Referring Code or Reference Standard.
- D. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2024.
- E. NFPA 101 - Life Safety Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. UL 268 - Standard for Smoke Detectors for Fire Alarm Systems; Current Edition, Including All Revisions.
- G. UL 268A - Standard for Smoke Detectors for Duct Application; Current Edition, Including All Revisions.
- H. UL 521 - Standard for Heat Detectors for Fire Protective Signaling Systems; Current Edition, Including All Revisions.
- I. UL 864 - Control Units and Accessories for Fire Alarm Systems; Current Edition, Including All Revisions.
- J. UL 1971 - Standard for Signaling Devices for the Hearing Impaired; Current Edition, Including All Revisions.

3.02 SCOPE

- A. Where there is an existing fire alarm system it will be expanded upon to provide proper coverage of signaling and detection per applicable codes.
- B. The contractor shall remove the existing field devices (where applicable) from the building prior to demolition. The contractor shall provide new field equipment to supplement the quantity of existing devices to meet applicable building codes for the new construction. In new construction, all devices and equipment shall be new.
- C. The contractor shall furnish and install a complete distributed microprocessor based 24VDC, electrically supervised, MULTIPLEX, integrated fire alarm and voice evacuation (where applicable) system as specified herein and indicated on the drawings. The system shall include, but not be limited to, all control equipment, remote transponders, printer, power supplies, signal initiating and signaling devices, conduit, wire, fittings, and all other accessories required to provide a complete and operable system.
- D. The system shall operate as a non-coded, continuous sounding system which will sound alarm devices until manually silenced, as herein specified.
- E. The system shall be wired as a Class B supervised system for all circuits.
- F. The installing contractor shall include at minimum 6 months of monitoring services.

3.03 CODES AND STANDARDS

- A. The system shall comply with the applicable Codes and Standards as follows:
 - 1. National Electrical Code - Article 760.
 - 2. National Fire Protection Association Standards: NFPA 70 NEC

3. NFPA 72 National Fire Alarm Code (2013) NFPA 90A Air Conditioning
4. NFPA 101 Life Safety Code UL 1971 Visual Devices ANSI 117.1 Visual Devices
5. Local & State Building Codes (Including all adopted amendments)
6. Texas Accessibility Standards (TAS) 05 Americans with Disabilities Act (ADA)
7. Requirements of Local Authorities having Jurisdiction
8. Underwriters Laboratory Requirements and Listings for use in Fire Protective Signaling Systems as follows:
9. UL 864 Control Panels (9th Edition) UL 268 Smoke Detectors - Systems UL 268A Duct Smoke Detectors
10. UL 521 Heat Detectors
11. UL 228 Door Holder-Closers

3.04 INSTALLING CONTRACTOR'S RESPONSIBILITY

- A. The installing fire alarm contractor is responsible for the design of a code compliant system, which meets the intent of all State and Local Authority Having Jurisdiction Codes and their adopted amendments along all permitting of such plans and associated permit fees. Reference and coordinate with all contract specifications and plans.

3.05 ACCEPTABLE MANUFACTURERS

- A. To establish the type, quality, and features of system required, the equipment specified is that of the NOTIFIER Fire Systems. System must be compatible with Notifier Onyx workstation where applicable.
- B. All equipment, materials, accessories, devices, etc. covered by the specifications and/or noted on the contract drawings shall be new and unused and be U.L. listed for their intended use.
- C. All references to manufacturer's or supplier's model numbers and other pertinent information herein is intended to establish a minimum standard of quality, performance and features required. All equipment proposed as an EQUAL to that specified shall COMPLETELY conform to the specifications herein.
- D. Equipment of other manufacturer's or supplier's may be considered as an equal to that specified provided that completely marked and identified catalog sheets of all proposed equipment is provided to the architect/ engineer for review ten (10) days prior to the date of bid for evaluation. In addition, a list of the contractor's qualifications and any exceptions to the specifications must be provided for review. Approval for any such substitution of equipment must be obtained in writing from the architect/engineer five (5) days prior to bid.
- E. Acceptable fire alarm systems manufacturer:
 1. NOTIFIER Fire Systems (Must be an Authorized Distributor)
 2. Other manufacturers will be considered upon approval by Owner or Engineer.

3.06 GENERAL REQUIREMENTS

- A. Contractor Qualifications:
 1. The equipment supplier shall be an authorized and designated representative of the Fire Alarm Manufacturer to sell, install, and service the proposed manufacturer's equipment and shall be approved by the Owner/Engineer to perform the work.
 2. The equipment supplier and installing contractor shall be licensed by the State Fire Marshall to sell, install, and service fire alarm systems as required by Article 5.43-2 of the Texas Insurance Code.
 3. The installing contractor and/or equipment supplier shall have on his staff a minimum of three (3) installation superintendents who are licensed by the State Fire Marshall's office for such purpose and under whose supervision installation, final connections, and check out will take place as required by the Texas Insurance Code.

4. The installing contractor or equipment supplier shall have on staff a minimum of one (1) certified NICET Level III state licensed fire alarm planner under whose supervision system design shall take place.
5. The installing contractor shall provide 24 hour, 365 days per year emergency service with qualified and state licensed service technicians.
6. The installing contractor shall have been actively engaged in the business of selling, installing, and servicing fire alarm systems for at least ten (10) years.

3.07 SUBMITTALS

- A. The installing contractor and/or equipment manufacturer shall provide complete and detailed shop drawings and include:
 1. Control panel configuration including wiring and interconnection schematics.
 2. Complete point to point wiring diagram showing terminal connections to all system devices.
 3. Riser wiring diagram and associated zoning/addressing configurations with associated conduit sizes.
 4. Complete floor plan drawings locating all devices associated with the fire alarm system. Floor plan drawings shall include conduit and wiring routing complete with conduit sizing and number of conductors by type. Floor plans shall be on AutoCAD.
 5. Factory data sheets on each piece of equipment to be used and so marked as to model, dimensions, size, voltage, and configuration.
 6. Detailed system description in this specification format describing system functions and operation. All specification variations and deviations shall be clearly noted and marked.
 7. Complete Bill of Material for reference.
 8. Programming matrix defining all input/output functions and zoning.
 9. Power supply and battery calculations.
 10. Written certification from the manufacturer stating that the distributor is authorized to sell, service and install the proposed fire alarm system.
- B. All submittal data will be in bound form with contractor's name, supplier's name, project name, and state fire alarm license number adequately identified.
- C. Only basic equipment devices have been shown on the contract drawings. Specific wiring between equipment/devices has not been shown. It is the contractor's responsibility to submit for approval the COMPLETE ENGINEERED system configuration and layout showing all devices, wiring, conduit, and locations along with other required information as specified herein.

3.08 COORDINATION

- A. It shall be the responsibility of the installing contractor to coordinate all requirements surrounding installation of the fire alarm system with all trades including, but, not exclusive of: electrical contractor, sprinkler contractor, and HVAC/controls contractor and intercom system. Adequate coordination shall be provided to insure proper installation and interface to all peripheral items required to interact with the fire alarm and communication system to provide a complete and functional life safety system.

PART 2 GENERAL

4.01 SYSTEM FUNCTIONAL OPERATION

- A. Alarm Detection
 1. When a fire alarm condition is detected via the main fire control panel by any of the system alarm initiating devices, the following functions shall occur:
 - a. The system common alarm LED on the CPU Module shall flash. The internal audible trouble device shall sound. Acknowledging the alarm condition shall silence the audible trouble device and revert the flashing common alarm LEDs to a steady state.

- b. A 640 character back-lit LCD Display shall indicate all applicable information associated with the alarm condition including: zone, device type, device location, and time of alarm. Location and zoning messages shall be custom field programmed to respective premises.
 - c. Any remote annunciator LCD display associated with the alarm zone shall be activated as herein specified.
 - d. The remote off-site monitoring shall transmit alarm signals to an Approved Central Supervising Station. (Central station connection, phone lines and service provided by Owner).
 - e. All automatic events programmed to the alarm point shall be executed and the associated indicating devices and/or outputs activated.
 - f. Alarm tones shall sound throughout the facility. Upon expiration of the alert tone, a digitized predetermined voice evacuation message shall be automatically transmitted throughout the facility. The system shall have the capability to generate multiple distinct digital messages as determined by event-initiated programs.
 - g. Flash all strobe lights (visual signals) throughout the facility.
 - h. Recall elevators to ground floor as specified herein, or to the alternate floor if the alarm condition originates on the ground floor.
 - i. Unlock all electrically locked doors.
- B. Print status on the system printer (where applicable).
 - 1. All designated "non-silenceable" auxiliary control functions shall remain in operation (even upon silencing of audible alarms) until such time as the control panel is cleared and reset manually (i.e. fan control outputs, central station interface, elevator recall interface, etc.).
 - 2. In addition, remote annunciators shall be located where indicated. The annunciators shall duplicate the control panel alarm status indicators (for selected system zones/points) and in addition, annunciate any system trouble conditions and operate as herein specified.
- C. SUPERVISORY CONDITION
 - 1. When a supervisory condition is detected via the main fire control panel by any of the system supervisory initiating devices, the following functions shall occur:
 - a. The system common supervisory LED on the CPU Module shall flash. The internal audible trouble device shall sound. Acknowledging the supervisory condition shall silence the audible device and revert the flashing common supervisory LED's to a steady state.
 - b. A 640 character back-lit LCD Display shall indicate all applicable information associated with the supervisory condition including: zone, device type, device location, and time of the supervisory condition. Location and zoning messages shall be custom field programmed to respective premises.
 - c. Any remote annunciator LCD display associated with the supervisory signal shall be activated as herein specified.
 - d. The remote off-site monitoring shall transmit supervisory signals to an Approved Central Supervising Station.
 - e. Print status on the system printer.
- D. TROUBLE CONDITION
 - 1. When a trouble condition is detected by the CPU, one of the system initiating alarm or SLC Circuit(s), the following functions shall immediately occur:
 - a. The system trouble LED on the CPU module shall flash and the internal audible trouble device shall sound. Acknowledgment of the trouble condition shall silence the audible trouble device and cause all trouble LED's to illuminate steady.

- b. The 640 character alphanumeric LCD annunciator shall display all applicable information via the alphanumeric display associated with the respective trouble condition and its location.
- c. The system common trouble indicator on associated remote annunciators shall be illuminated as specified herein.
- d. The remote off-site monitoring shall transmit supervisory signals to an Approved Central Supervising Station.
- e. Print status on the system printer.

4.02 ZONING

- A. The system shall have the inherent capability to employ "Intelligent" smoke detectors and addressable interface devices capable of being recognized and annunciated at the main control panel on an individual basis. All zoning/device location information shall be totally field programmable to exact job requirements as approved by the architect/engineer.
- B. The system shall utilize remote amplifier cabinets for distributed voice communications (if needed), notification appliance circuits, and auxiliary control output circuits. Remote transponder panels shall communicate with the main CPU via the SLC data loop and be capable of being intermixed on the same loop as intelligent smoke detection and control modules.

4.03 ZONING

- A. The fire alarm control panel shall be Notifier series NFS2-640/NFS2-320/NFS2-3030 of which should be sized according to manufacturer specs. The control panel shall be modular in design utilizing DISTRIBUTED solid state MICROPROCESSORS and be capable of future expansion. The microprocessor based CPU shall be completely FIELD PROGRAMMABLE. CPU module shall provide for programmable non-volatile RAM memory utilizing integral lithium-based memory IC chips. All circuitry shall be U.L. listed for power-limited application.
- B. Central Processing Unit Module (CPU): The CPU shall contain and execute all custom time control functions or control-by-event programs for specified events. Time control events/programs shall be automatically overridden by priority fire alarm events. All programs shall be held in non-volatile programmable RAM memory and shall not be lost even if both system primary and secondary power failure occurs. The system shall include a trouble reminder feature to alert operating personnel to the continued presence of system trouble conditions.
- C. Display Interface Board (DIA): The DIA shall provide a 640-character back-lit, super-twist Liquid Crystal Display (LCD). It shall provide Light-Emitting Diodes (LED's) for AC POWER; SYSTEM ALARM; SYSTEM TROUBLE; DISPLAY TROUBLE; and DISABLE. The DIA shall provide a 25-key membrane keypad with control capability to command all system functions, status readouts, manual control action, and entry of any alphabetic or numeric information. The keypad shall include means to enter multiple five digit passwords to prevent unauthorized manual control or programming.
- D. CONTROL SWITCHES
 - 1. Acknowledge/step Switch
 - 2. Signal Silence Switch
 - 3. System Reset Switch 04 System Test Switch
 - 4. Lamp Test
- E. Loop Control/Expander Module (LCM/LEM): The LCM/LEM shall communicate and provide power to all devices on its loop over a single pair of wires. Each signaling line circuit shall provide the capability to support up to 159 smoke detectors and 159 monitor and control modules. The LCM/LEM shall receive digital/ANALOG information from all "intelligent" detectors and shall process this information to determine normal, alarm, trouble, and sensitivity conditions. The analog information may be used for automatic test and determination of

maintenance requirements. The LCM/LEM module shall individually monitor all "intelligent" detectors for sensitivity variation initiating a trouble condition should detector sensitivity "drift" become excessive. The system control unit shall have the capability to remotely read each detectors sensitivity, and if need be, electronically adjust the detector sensitivity as required for existing conditions within U.L. recommended limits. In addition, the system shall incorporate a "day/night" sensitivity feature.

- F. Non-Lock Walk Test: The system shall include a special non-lock "walk test" mode. The walk test mode can be initiated by loop, software zone, or globally as field selected. The following reports shall be capable of being generated:
 - 1. General results of all walk tested devices.
 - 2. Report all un-programmed devices installed.
 - 3. Report all programmed devices not installed.
 - 4. Report all devices not tested.
- G. Automatic Detector Test: The system shall include a special automatic detector test feature which permits reading and adjustment of the sensitivity of all intelligent detectors from the main control panel. In addition, the automatic test feature shall also permit the functional testing of any "intelligent" detector or addressable interface device individually from the main control panel. An automatic detector test shall occur automatically fourteen times each twenty- four hour period or be initiated manually from the FACP as desired. Automatic detector test sequencing shall be terminated upon receipt of a true alarm condition.
- H. Special System Reports: The system shall have the ability to generate and print, upon command, system and point status reports. Selection of 'system' read status provides the operator with global system programming information. Selection of 'point' read status provides the operator with selected individual point programming data.
- I. Field Programming: The system shall be 100% field programmable without the need for external computers or PROM programmers, and shall NOT require replacement of memory IC's. Systems requiring factory programming/re-programming OR REPLACEMENT OF MEMORY I.C. CHIPS shall not be acceptable. All programs shall be stored in non-volatile RAM memory. Programming shall be accomplished only after entering an appropriate and pre-selected five digit password security code. System programming mode shall not require the system to be taken off-line nor prohibit the system from performing its normal operations and routines. The system shall be capable of revising/changing programmed functions or system expansion at any time subsequent to initialization as described herein without factory modifications or factory programming. Field programming via the use of external computers may be considered provided programming can be accomplished on- site and the owner permanently furnished with required programming apparatus and software as part of this contract.
- J. Event History: The main fire alarm control panel shall have the resident ability to store a minimum of 4000 events as well as a separate 1000 event alarm-only file in chronological order of occurrence. Event history shall include all system alarms, troubles, operator actions, unverified alarms, circuit/point alterations, and component failures. Events shall be time and date stamped. Events shall be stored in non-volatile buffer memory. Access to history buffer shall be secured via five digit password security code. Systems not employing event history memory storage shall be required to furnish a printer/recorder for recording system events.
- K. Power Supply: The power supply shall provide all control panel and peripheral power needs with filtered power as well as regulated 24VDC power for external audio-visual devices. The audio- visual power may be increased as needed by adding additional modular expansion power supplies. All power supplies shall be designed to meet U.L. and NFPA requirements for POWER-LIMITED operation on all external signaling lines, including initiating circuits and indicating circuits. Power dedicated circuit and label as such on panels. Input power shall be 120VAC 60Hz. The power supply shall provide internal supervised batteries and automatic

charger. The power supply shall provide both positive and negative ground fault supervision, battery/charger fail condition, A.C. power fail indicators. The power supply shall also provide supervision of modular expansion power supplies as may be required. Contractor shall connect the 120V circuits to the emergency circuit/panels backed up by the generator. Batteries shall have 24 hours of standby capacity and 15 minutes of alarm capacity. Battery charger shall recharge batteries from full discharge to full charge over a 24-hour period. Switching from normal power to battery power and back shall occur automatically.

4.04 VOICE COMMUNICATIONS (WHERE APPLICABLE)

- A. The NOTIFIER Notifier Model NFC-50/100 or DVC with DAA Voice Command voice communications panel shall be modular in design utilizing solid state MICROPROCESSOR circuitry. The voice evacuation system shall integrate with the main fire alarm control panel. Side car voice evacuation systems are not acceptable. Voice system shall be used where required per code and local AHJ requirements.
- B. Communications Controls: The communications control panel shall incorporate the following controls and indicators:
 - 1. All call
 - 2. General alarm
 - 3. Audio trouble LED
 - 4. AUDIO LEVEL LED
 - 5. Manual tone/MESSAGE select switches with LED indicators.
 - 6. Communications zone select switches and select indicators
 - 7. Communications monitor speaker with volume control
 - 8. Dynamic paging microphone
- C. Paging
 - 1. The microprocessor based one way paging system shall be provided with a means to selectively activate voice, tones or digitized messages to any or all zones in the system via electronic membrane touch-pad controls. In addition, visual indication by zone will be provided.
 - 2. Each audio/speaker circuit will be totally supervised for opens, shorts or grounds with direct shorts prohibiting selection of the respective zone. All audio circuits shall be POWER LIMITED. Each speaker zone shall be provided with an amber trouble LED for circuit trouble conditions and an active/on LED indicator.
 - 3. Alarm/Paging zones shall be provided as required.
- D. Voice
 - 1. The voice communications center DVC with DAA shall be a microprocessor based, supervised, multi-function, audio generator. The communications generator shall contain:
 - a. Independent Voice communications CPU.
 - b. Non-volatile
 - c. One custom digitized message circuit.
 - d. Up to four selectable tone generator/oscillators.
 - e. Each sub-circuit of the communications center shall be fully supervised and failure of any tone oscillator or digital message generator shall revert the system to the default standby generator.
 - 2. The system shall be provided with a custom field programmable digitized message.
 - 3. The system shall provide adequate audio amplification. The system shall be capable of amplifier capacity and expansion as required. Each amplifier shall be continuously monitored electronically for proper output level. Each unit shall be equipped with diagnostic indicators. Each amplifier shall provide a minimum of 50 watts of 25 VRMS of power. Each unit shall be equipped with its own individual power/pilot LED, audio input trouble LED, battery input trouble LED, and amplifier trouble/fail LED. Provide

amplification for 1/2 watt per speaker plus 25% spare capacity. Electrical Contractor shall provide and install a 120 VAC dedicated circuit to each remote amplifier cabinet (if needed).

4. Secondary cell dialer shall be Model # Starlink SLE-LTEVI Fire or owner approved equal.

4.05 FIELD DEVICES

A. Multi Criteria Smoke and Heat Detector (FCO-951 or FCO-951IV):

1. Notifier Model FAPT-851 or latest intelligent multi criteria acclimating detector shall be provided where shown on the drawings. The intelligent multi criteria Acclimate Plus and/or Clip Mode detector shall be an addressable device that is designed to monitor a minimum of photoelectric and thermal technologies in a single sensing device. The design shall include the ability to adapt to its environment by utilizing a built-in microprocessor to determine its environment and choose the appropriate sensing settings. The detector design shall allow a wide sensitivity window, no less than 1 to 4% per foot obscuration. This detector shall utilize advanced electronics that react to slow smoldering fires and thermal properties all within a single sensing device.
2. The microprocessor design shall be capable of selecting the appropriate sensitivity levels based on the environment type it is in (office, manufacturing, kitchen etc.) and then have the ability to automatically change the setting as the environment changes (as walls are moved or as the occupancy changes).
3. The intelligent multi criteria detection device shall include the ability to combine the signal of the thermal sensor with the signal of the photoelectric signal in an effort to react hastily in the event of a fire situation. It shall also include the inherent ability to distinguish between a fire condition and a false alarm condition by examining the characteristics of the thermal and smoke sensing chambers and comparing them to a database of actual fire and deceptive phenomena.
4. The detector shall be semi-flush ceiling mounted and be provided with modular detector head with twist-lock base.

B. Intelligent Duct Detector

1. Notifier model DNR series duct mounted "intelligent" photoelectric smoke detectors shall be provided where shown on the drawings. Detectors shall operate on the same principles and exhibit the same basic characteristics as area type "intelligent" photoelectric smoke sensors. The unit shall be capable of interchanging/accepting either photo-electronic or ionization type sensors. The detector shall operate in air velocities of 300 FPM to 4,000 FPM. Each detector shall interface directly to the system SLC loop without the requirement of interface zone modules.
2. The unit shall consist of a clear molded plastic enclosure with integral conduit knockouts. The unit shall be provided with clear faceplate cover to provide visual viewing of detector/sensor for monitoring sensor operation and chamber condition. The duct housing shall be provided with gasket seals to insure proper seating of the housing to the associated ductwork. Each unit's sampling tubes shall extend the width of the duct and be provided with porosity filters to reduce sensor/chamber contamination. Detectors shall be installed per NFPA 90A, and be listed with the fire alarm control panel. A remote LED shall be located on the corridor ceiling adjacent to the respective detector where detectors are not plainly visible or concealed from view.

C. Intelligent Thermal Detectors

1. Notifier Model FST-951R analog, fixed temperature, thermal detectors shall be provided where indicated on the drawings. The detectors shall use dual electronic thermostats to measure temperature levels in the chamber and shall, on command from the control panel, send data to the panel representing the analog temperature level.
2. The detectors shall provide dual alarm and power/status LED's. Status LED's shall flash under normal conditions, indicating that the detector is operational and in regular

-
- communication with the control panel. Both LED's may be placed into steady illumination by the control panel, indicating that an alarm condition has been detected. An output connection shall also be provided in the base to connect an external remote alarm LED.
3. The detector shall be semi-flush ceiling mounted and be provided with modular detector head with twist-lock base.
- D. Addressable Manual Stations
1. Notifier Model NBG-12LX manual stations shall be provided where indicated on the drawings. The manual stations shall contain the intelligence for reporting address, identity, alarm and trouble to the fire alarm control panel
 - a. The manual pull station shall be constructed of durable molded polycarbonate material, and shall be RED in color with raised white lettering. Stations shall be of the dual action type.
 - b. Manual stations (when required), shall be located not more than 5 feet (152.4 cm) from the entrance to each exit. Additional manual stations shall be located so that the travel distance to the nearest manual station does not exceed 200 feet (6096 cm).
 - c. Manual station heights shall be a minimum of 42" and a maximum of 48" measured vertically, from the finished floor level to the activating handle or lever.
 - d. Systems using automatic smoke detection or water flow detection devices to initiate the fire alarm system, not less than one (1) manual station shall be provided to initiate a fire alarm signal. The manual station shall be located where required by the Authority Having Jurisdiction, per NFPA 101. Provide Stopper II cover on all manual stations where shown on plans.
- E. Monitor Module
1. Notifier model FMM-101 addressable monitor modules shall be provided where required to interface to contact alarm devices. The monitor module shall be used to connect a supervised zone of conventional initiating devices to an intelligent SLC loop.
 2. The monitor module shall provide address-setting means using rotary decimal switches. No binary coding shall be required.
- F. Control Module
1. Notifier model FCM/FRM control/relay modules or approved equal shall be provided where required to provide audible alarm interface and/or relay control interface. The control module shall be used to connect a supervised zone of conventional indicating devices to an intelligent loop. The zone may be wired class A or class B - field selected. The control module may be optionally wired as dry contact (form C) relay.
 2. The control module shall provide address-setting means using rotary decimal switches. No binary coding shall be required. A status LED shall be provided which shall flash under normal conditions, indicating that the control module is operational and in regular communication with the control panel. The LED shall illuminate steady when the device is actuated via the fire alarm control panel.
- G. Remote LCD Alpha-Numeric Annunciators, Remote Mic with Switches
1. Provide where indicated on the drawings, a Notifier LCD-160 640 character remote LCD alpha-numeric annunciator or approved equal to annunciate all system events and duplicate the displayed status at the main FACP. The annunciator shall be a backlit eighty-character LCD display and operate via the system RS485 or RS232 serial output terminal from the main FACP. The LCD display shall automatically illuminate upon receipt of an alarm or trouble condition. The illumination source shall extinguish during normal/standby mode to conserve power. The unit shall operate from FACP 24VDC power and function during system power failure while the system resides on standby batteries. The remote LCD annunciator shall include:
 - a. Integral time-date clock
 - b. Time-date select switch

-
- c. Time-date/contrast adjust
 - d. Display/step switch
 - e. System reset
 - f. System silence
 - g. System acknowledge
 - h. Integral trouble buzzer
 - i. Point enable/disable capability
 - j. Full QWERTY keypad for system programming.
 - 2. Annunciator shall upon command display the first system alarm, last alarm, and system alarm count. The unit shall be equipped with an integral lamp test feature. The unit shall be semi flush mounted where shown.
- H. Speakers/Horn (Where Applicable)
- 1. Speakers shall be listed under U.L. standard 1480, meet all specifications of the Life Safety Code and be capable of reproducing both tone alerts and voice communication instructions. Speakers/Horns shall be System Sensor L Series or equal by Wheelock. Speakers or approved equal shall have built in matching transformer, field selectable multiple power taps and circuitry for speaker/line supervision. Speakers shall be provided with screw terminal connection points. Speakers shall be 4" square or round with textured white decorative grill. Speakers shall be tapped to produce a minimum sound-pressure level of 87 dBA at 10 feet (304.8 cm). Speakers shall be ceiling mounted as located on the drawings.
- I. Speakers/Horns with Integral Strobe Light
- 1. Speakers shall be listed under U.L. standard 1480, meet all specifications of the Life Safety Code and be capable of reproducing both tone alerts and voice communication instructions. Speakers/strobe units shall be System Sensor L Series. Speakers shall have built in matching transformer, field selectable multiple power taps and circuitry for speaker/line supervision. Speakers shall be provided with screw terminal connection points. Speaker/Strobes shall be white. Each speaker/strobe shall be equipped with an integral high intensity visual alarms shall be Xenon strobe type producing a minimum of 15 candela on a 24 VDC limited energy supervised circuit. Each strobe light shall be capable of providing multi candela output. Alarm devices shall be designated to be ceiling mounted as indicated on the drawings. Signals shall operate in unison with audible alarm appliances. High intensity visual signals shall be of solid state low current design and listed to U.L. Standard 1971 All strobe lights shall be synchronized.
- J. High Intensity Visual Signals
- 1. Provide System Sensor L Series or equal by Wheelock strobe lights were shown on the drawings. High intensity visual signals shall be installed where shown on the drawings and as may be required by the Americans with Disabilities Act (Public Law 101-336), Texas Accessibility Standards and NFPA 72, Chapter 6. Strobe lights shall be red. High intensity visual alarms shall be Xenon strobe type producing a minimum of 15 candela on a 24 VDC limited energy supervised circuit. Each strobe light shall be capable of providing multi candela output. Alarm devices shall be designated to be wall or ceiling mounted as indicated on the drawings. Signals shall operate in unison with audible alarm appliances. High intensity visual signals shall be of solid state low current design and listed to U.L. Standard 1971. All strobe lights shall be synchronized.
- K. Protective Covers
- 1. Provide protective covers on fire alarm notification appliance devices located in multi-purpose rooms and gymnasium locker rooms. These protective covers shall be manufactured by Safety Technology International, Inc. (STI). These covers shall be provided on all devices including but not limited to audible and visual devices, and manual pull stations. The mounting of a device shall be reinforced to enable the protective covers

to protect the fire alarm devices. In gymnasiums, provide wire guards or approved equal. No horns in covers.

- L. Sprinkler Waterflow Switch
 - 1. Sprinkler waterflow switches shall be installed where indicated on the drawings. Each unit shall contain one set of SPDT alarm contacts. Waterflow switches shall be provided and installed by the fire protection contractor, and connected by the fire alarm contractor.
- M. Sprinkler Valve Supervisory Switch
 - 1. Sprinkler valve supervisory switches shall be installed on each valve as indicated on the drawings. Each unit shall contain one set of SPDT contacts. Sprinkler valve supervisory switches shall be provided, installed, and adjusted by the fire protection contractor, and connected by the fire alarm contractor.
- N. Auxiliary AHU Relays
 - 1. Notifier/Air Products Model MR-101/C relays or approved equal shall be provided for HVAC and AHU control and interface. Relays shall be heavy duty type and rated up to 10 amps at 24 VDC, 60 HZ. Relays shall be provided with NEMA 1 dust cover assembly and be provided with SPDT contacts as well as activated LED indicator. All interface relays shall be connected to a supervised notification appliance circuit.
- O. Field Charging Power Supplies
 - 1. Provide Notifier FCPS-24S6/8 or PSE-10 power supplies with battery backup as required. Electrical Contractor shall provide a 120 VAC dedicated emergency circuit to each power supply.
- P. Conventional Weatherproof Thermal Detector
 - 1. When heat detection devices are located in harsh and/or moist environments, such as showers and similar areas, which are subject to high humidity, the following device shall be provided: Weatherproof Heat Detector 135 F Rate Compensated shall be provided. The detector shall mount in a weatherproof 4" electrical box with a ½" N.P.T. threaded hub. This detector shall be connected to an addressable monitor module.
- Q. Digital Alarm Transmitter Communicator
 - 1. Provide Digital alarm communicator shall be multi-channel UDACT-2. Provide point ID reporting to central monitoring station. (Owner will provide Analog or Digital to Analog Telephone lines cabling to the fire alarm panel, Service and Connection by owner).
- R. Provide a minimum of (50) initiating points for future portable buildings where applicable. Provide (2) dedicated NAC circuits pulled to the exit point above the ceiling. Refer to floor plan for location.
- S. Contractor shall provide a 120 VAC dedicated emergency circuit to each amplifier.

PART 3 EXECUTION

5.01 INSTALLATION

- A. Wiring:
 - 1. All wiring shall be in accordance with NFPA 72 and the National Electrical Code, Local Codes, and article 760 of NFPA Standard 70. All wiring sizes shall conform to recommendations of the equipment manufacturer, and as indicated on the engineered shop drawings.
 - 2. Limited energy FPLP wire shall be installed provided such wire is U.L. Listed to U.L. TEST910 for such applications and is of the low smoke producing fluorocarbon type and complies with NEC Article 760 if so approved by the local authority having jurisdiction.
 - 3. All wiring for SLC signaling circuits shall be of the twisted, low capacitance type to guard against outside RF and EMF interference and induced noise.

-
4. All wiring shall be run in a supervised fashion (i.e. no branch wiring or dog- legged wiring) per NFPA requirements such that any wiring disarrangement will initiate the appropriate trouble signals via the main control panel per NFPA and U.L. requirements.
 5. Wiring splices shall be kept to a minimum with required splices to be made in designated terminal boxes or at field device junction boxes. Transposing or color code changes of wiring will not be permitted. End-of-line supervisory devices shall be installed with the last device on the respective circuit. Said device shall be appropriately marked designating it as the terminating device on the respective circuit.
 6. No A.C. wiring or any other wiring shall be run in the same conduit as fire alarm wiring.
- B. Open Wiring
1. Systems utilizing open wiring techniques with low smoke plenum cable.
 2. Support wire clear of knock out panels, access panels, and maintenance spaces for equipment. Wire and cable shall be run using wire management techniques supporting cable as close as possible to within one foot of the floor or roof rafters. Wire supports shall be directly fastened to the structure on a maximum of five foot centers. Wire routing shall be parallel and perpendicular to building lines. The wire and cable shall be secured with tie wraps or carrier wire. Sagging in excess of three inches will not be allowed nor will bending of the supporting ring structure.
- C. Conduit/Raceway and 120 VAC Power wiring
1. Electrical Contractor to provide conduit and raceway system and shall be installed in the mechanical, electrical and telephone rooms and as required by NFPA 70. Electrical Contractor shall provide and install all required dedicated 120 VAC power circuits for the fire alarm system including the main fire alarm panel, remote amplifier panels and remote strobe light power supplies. Contractor shall connect the 120V circuits to the emergency circuit/panels backed up by the generator.
- D. Minimum Wire Sizes Shall Be as Follows:
1. Signaling Line Circuits: 18 AWG Twisted (Low Capacitance)
 2. Notification Appliance Circuits: 14 AWG
 3. Relay Control Circuits: 18 AWG
 4. Speaker Circuits: 16 AWG Twisted/Shielded
- E. All wire shall be plenum rated.
- 5.02 TEST AND REPORTS
- A. A state licensed and factory trained technical representative of the manufacturer shall supervise the final control panel connections and testing of the system. Upon completion of the acceptance tests, the owner and/or his representatives shall be instructed in the proper operation of the system. Instruction shall be 4 hours minimum.
- B. The installing contractor shall functionally test each and every device in the entire system for proper operation and response. In addition, each circuit in the system shall be fully tested for wiring supervision. Any items found not properly installed or non-functioning shall be replaced or repaired and re-tested. Provide a device list of every device and tested results in an excel format.
- C. The installing contractor shall provide a complete written report on the functional test of the entire system. A copy of the test report shall be provided with maintenance manuals. The test report shall be signed and dated by the licensed fire alarm superintendent responsible for supervising the final system test and checkout.
- D. The installing contractor's fire alarm technician shall test the entire system in the presence of the local authorities having jurisdiction. The contractor shall be responsible for making any changes, adjustments, or corrections as may be required by the local authorities.

- E. It is the intent of these specifications and of the architect/engineer that a continued program of system maintenance be continued by the owner in compliance with NFPA Standard 72, Chapter 7. It is mandatory that the installing contractor shall provide such services and make available these services to the owner upon completion of the project.

5.03 WARRANTY

- A. The fire alarm system, including labor and material, shall be free from defects in workmanship and materials, under normal use and service, for a period of one year from the date of acceptance or beneficial occupancy, whichever shall occur first. Any equipment or workmanship shown to be defective shall be repaired, replaced or adjusted during normal working hours at no cost to the owner.
- B. The equipment manufacturer shall be represented by a local service organization and the name of such shall be furnished to the Owner, Architect, and Engineer.

5.04 FLOOR PLANS

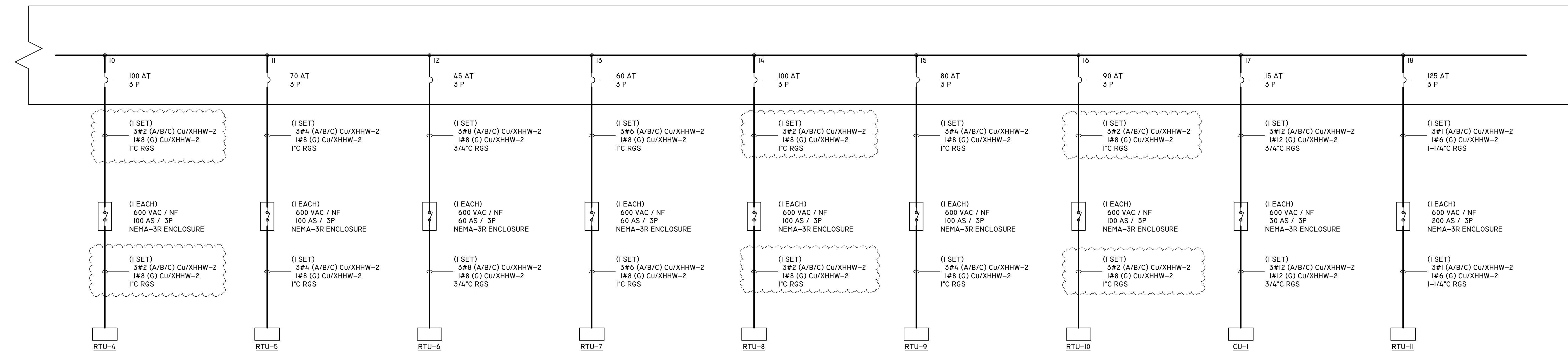
- A. Provide (1) electronic copy and (1) hard copy of the approved fire alarm drawings as well as a FML-009 with approved State of Texas installation tags posted at fire panel.

END OF SECTION

OPENING SCHEDULE										
MARK	ROOM NAME	DOOR TYPE	DOOR LEAF	OPENING		THICKNESS	MATERIAL	DOOR FINISH	FRAME TYPE	NOTES
				WIDTH	HEIGHT					
X100	VESTIBULE	C1	CASE OPENING	11'- 0"	14'- 0"		OPENING	NONE		
X104	SHOE LOBBY	B1	CASE OPENING	6'- 0"	12'- 0"		OPENING	NONE		
X105	SHOE LOBBY	B1	CASE OPENING	6'- 0"	12'- 0"		OPENING	NONE		
X106	LOBBY	B2	CASE OPENING	7'- 0"	12'- 0"		OPENING	NONE		
X107	EAST ENTRY	B2	CASE OPENING	7'- 0"	12'- 0"		OPENING	NONE		
X108	LOBBY	B2	CASE OPENING	7'- 0"	12'- 0"		OPENING	NONE		
X109	JAMAAT LOBBY	B2	CASE OPENING	7'- 0"	12'- 0"		OPENING	NONE		
X110	WEST ENTRY	B2	CASE OPENING	7'- 0"	12'- 0"		OPENING	NONE		
X111	MAWAID LOBBY	A	CASE OPENING	13'- 0"	10'- 0"		OPENING	NONE		
X112A	MAWAID	A	CASE OPENING	4'- 6"	9'- 0"		OPENING	NONE		
X112B	MAWAID	B2	CASE OPENING	6'- 0"	12'- 0"		OPENING	NONE		
X112C	LOBBY	B2	CASE OPENING	6'- 0"	12'- 0"		OPENING	NONE		
X112D	MAWAID	B2	CASE OPENING	6'- 0"	12'- 0"		OPENING	NONE		
X112E	MAWAID	B2	CASE OPENING	6'- 0"	12'- 0"		OPENING	NONE		
X112F	MAWAID	B2	CASE OPENING	6'- 0"	12'- 0"		OPENING	NONE		
X112G	MAWAID	B2	CASE OPENING	6'- 0"	12'- 0"		OPENING	NONE		
X112H	MAWAID	B2	CASE OPENING	6'- 0"	12'- 0"		OPENING	NONE		
X113	MAWAID ENTRY	C2	CASE OPENING	9'- 0"	12'- 9"		OPENING	NONE		
X126	MENS HANDWASH	A	CASE OPENING	5'- 0"	6'- 0"		OPENING	NONE		
X127	WOMENS HANDWASH	A	CASE OPENING	5'- 0"	6'- 0"		OPENING	NONE		
X137A	KITCHEN	A	CASE OPENING	6'- 0"	5'- 0"		OPENING	NONE		36" FROM FINISH FLOOR
X137B	KITCHEN	A	CASE OPENING	6'- 0"	5'- 0"		OPENING	NONE		36" FROM FINISH FLOOR
X216	RECEPTION	B3	CASE OPENING	7'- 0"	6'- 0"		OPENING	NONE		

DOOR SCHEDULE 1st FLOOR													
MARK	ROOM NAME	DOOR TYPE	DOOR LEAF	DOOR			MATERIAL	DOOR FINISH	GLAZING	HARDWARE	FIRE RATING	NOTES	
				WIDTH	HEIGHT	THICKNESS							
A100	VESTIBULE	I	PAIR	8'- 0"	10'- 0"	0'- 1 3/4"	IRON	PAINT	G1				
A102A	MENS MASJID	Q	PAIR	6'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	G3	1A			
A102B	MENS MASJID	M	PAIR	6'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	G3	2A			
A102C	MENS MASJID	R	QUADRUPL	3'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	G3	2B			
A102D	MENS MASJID	M	PAIR	6'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	G3	2A			
A102E	MENS MASJID	Q	PAIR	6'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	G3	2A			
A103	QIBLA	E	SINGLE	2'- 6"	8'- 0"	0'- 1 3/4"	IRON	PAINT	G1	1B			
A104	SHOE LOBBY	G	PAIR	6'- 0"	8'- 0"	0'- 1 3/4"	IRON	PAINT	G1	1C			
A105A	SHOE LOBBY	G	PAIR	6'- 0"	8'- 0"	0'- 1 3/4"	IRON	PAINT	G1	1C			
A105B	SHOE LOBBY	Q	PAIR	6'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	G3	2A			
A107	EAST ENTRY	G	PAIR	6'- 0"	8'- 0"	0'- 1 3/4"	IRON	PAINT	G1	1C			
A108A	LOBBY	K	SINGLE	3'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	G3	2C			
A108B	LOBBY	M	PAIR	6'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	G3	2A			
A108C	LOBBY	K	SINGLE	3'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	G3	2C			
A110	WEST ENTRY	G	PAIR	6'- 0"	8'- 0"	0'- 1 3/4"	IRON	PAINT	G1	1C			
A113	MAWAID SHOE LOBBY	H	PAIR	9'- 0"	14'- 0"	0'- 1 3/4"	IRON	PAINT	G1	1C			
A114	ADA RESTROOM	JW	SINGLE	3'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	NONE	3A			
A115A	AV ROOM	Q	PAIR	6'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	G3	4A			TRANSOM TO BE G2
A115B	AV ROOM	JM	SINGLE	2'- 6"	8'- 0"	0'- 1 3/4"	HOLLOW METAL	PAINT	NONE	4B	1 HR		
A117	STAIR 1	JM	SINGLE	3'- 0"	8'- 0"	0'- 1 3/4"	HOLLOW METAL	PAINT	NONE	5A	1 HR		
A118	FIRE RISER ROOM	DH	SINGLE	2'- 6"	8'- 0"	0'- 1 3/4"	HOLLOW METAL	PAINT	NONE	6A			
A119	ADA RESTROOM	JW	SINGLE	3'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	NONE	3A			
A120	TAKHAT ROOM	Q	PAIR	6'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	G3	7A			TRANSOM TO BE G2
A121A	MENS RESTROOM	JW	SINGLE	3'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	NONE	8A			
A121B	MENS RESTROOM	JPL	SINGLE	2'- 6"	7'- 0"	0'- 1 3/4"	PLASTIC LAMINATE	PAINT	NONE	3B			
A121C	MENS RESTROOM	JP	SINGLE	2'- 0"	6'- 0"	0'- 1 3/4"	PHENOLIC	PAINT	NONE				
A121D	MENS RESTROOM	JPL	SINGLE	2'- 6"	7'- 0"	0'- 1 3/4"	PLASTIC LAMINATE	PAINT	NONE	3B			
A121E	MENS RESTROOM	JP	SINGLE	2'- 0"	6'- 0"	0'- 1 3/4"	PHENOLIC	PAINT	NONE				
A121F	MENS RESTROOM	JPL	SINGLE	2'- 0"	7'- 0"	0'- 1 3/4"	PLASTIC LAMINATE	PAINT	NONE	3B			
A121G	MENS RESTROOM	JP	SINGLE	2'- 0"	6'- 0"	0'- 1 3/4"	PHENOLIC	PAINT	NONE				
A122A	WOMENS RESTROOM	JW	SINGLE	3'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	NONE	8A			
A122B	WOMENS RESTROOM	JPL	SINGLE	2'- 6"	7'- 0"	0'- 1 3/4"	PLASTIC LAMINATE	PAINT	NONE	3B			
A122C	WOMENS RESTROOM	JP	SINGLE	2'- 0"	6'- 0"	0'- 1 3/4"	PHENOLIC	PAINT	NONE				
A122D	WOMENS RESTROOM	JPL	SINGLE	2'- 0"	7'- 0"	0'- 1 3/4"	PLASTIC LAMINATE	PAINT	NONE	3B			
A122E	WOMENS RESTROOM	JP	SINGLE	2'- 0"	6'- 0"	0'- 1 3/4"	PHENOLIC	PAINT	NONE				
A124	GHUSUL	L	PAIR	6'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	NONE	4J			
A125	ELECTRICAL	DH	SINGLE	3'- 0"	8'- 0"	0'- 1 3/4"	HOLLOW METAL	PAINT	NONE	9A			
A128	LAUNDRY	JW	SINGLE	3'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	NONE	8A			
A129	JAMAAT CONFERENCE	M	PAIR	6'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	G3	8B			
A130A	JAMAAT OFFICE	JD	SINGLE	3'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	NONE	4C			
A130B	JAMAAT OFFICE	JD	SINGLE	3'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	NONE	4C			
A131	VIP ROOM	JD	SINGLE	6'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	NONE	4C			
A132A	VIP RESTROOM	N	SINGLE	2'- 6"	7'- 0"	0'- 1 3/4"	SOLID CORE WOOD	PAINT	NONE	10A			
A132B	VIP RESTROOM	N	SINGLE	2'- 6"	7'- 0"	0'- 1 3/4"	SOLID CORE WOOD	PAINT	NONE	10A			
A133A	VIP KITCHEN	JW	SINGLE	3'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	NONE	4C			
A133B	VIP KITCHEN	JW	SINGLE	3'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	NONE	4C	1 HR		30" KICK PLATE
A137A	KITCHEN	T	PAIR	6'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	NONE	4E	1 HR		30" KICK PLATE
A137B	KITCHEN	U	SINGLE	4'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	NONE	4F	1 HR		30" KICK PLATE
A137C	KITCHEN	DH	SINGLE	4'- 0"	8'- 0"	0'- 1 3/4"	HOLLOW METAL	PAINT	NONE	9B			30" KICK PLATE
A140	COOLER	P	SINGLE	3'- 0"	7'- 0"	0'- 4"	HOLLOW METAL	PAINT	NONE	8/0			
A141	FREEZER	P	SINGLE	3'- 0"	7'- 0"	0'- 4"	HOLLOW METAL	PAINT	NONE	8/0			
A142A	PANTRY/TIFFIN	JM	SINGLE	4'- 0"	8'- 0"	0'- 1 3/4"	HOLLOW METAL	PAINT	NONE	4G			30" KICK PLATE
A142B	PANTRY/TIFFIN	F	PAIR	6'- 0"	8'- 0"	0'- 1 3/4"	HOLLOW METAL	PAINT	G1	6B			30" KICK PLATE
A144A	STAIR 3	JM	SINGLE	3'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	NONE	5A	1 HR		
A144B	STAIR 3	DH	SINGLE	3'- 0"	8'- 0"	0'- 1 3/4"	HOLLOW METAL	PAINT	NONE	9B			
A145	AV ROOM	JW	SINGLE	2'- 8"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	NONE	4B			

DOOR SCHEDULE 2nd FLOOR													
MARK	ROOM NAME	DOOR TYPE	DOOR LEAF	DOOR			MATERIAL	DOOR FINISH	GLAZING	HARDWARE	FIRE RATING	NOTES	
				WIDTH	HEIGHT	THICKNESS							
A200A	CONFERENCE	K	SINGLE	3'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	G3	2D			
A200B	CONFERENCE	M	PAIR	6'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	G3	2A			
A200C	CONFERENCE	K	SINGLE	3'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	G3	2D			
A201A	SEHEN	M	PAIR	6'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	G3	2E			
A201B	SEHEN	M	PAIR	6'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	G3	2E			
A202A	WOMENS MASJID	M	PAIR	6'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	G3	2A			
A202B	WOMENS MASJID	M	PAIR	6'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	G3	2A			
A202C	WOMENS MASJID	K	SINGLE	3'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	G3	2A			
A202D	WOMENS MASJID	M	PAIR	6'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	G3	2A			
A202E	WOMENS MASJID	K	SINGLE	3'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	G3	2A			
A202F	WOMENS MASJID	M	PAIR	6'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	G3	2A			
A202G	WOMENS MASJID	M	PAIR	6'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	G3	2A			
A204	STAIR 1	JM	SINGLE	3'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	NONE	5A	1 HR		
A205	NURSERY	DW	SINGLE	3'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	NONE	4C			
A206	ADA RR	JPL	SINGLE	3'- 0"	8'- 0"	0'- 1 3/4"	PLASTIC LAMINATE	PAINT	NONE	3C			
A207	LOBBY	JW	PAIR	6'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	NONE	12A			
A208A	WOMENS RESTROOM	JW	SINGLE	3'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	NONE	8A			
A208B	WOMENS RESTROOM	JPL	SINGLE	2'- 6"	7'- 0"	0'- 1 3/4"	PLASTIC LAMINATE	PAINT	NONE	3B			
A208C	WOMENS RESTROOM	JP	SINGLE	2'- 0"	6'- 0"	0'- 1 3/4"	PHENOLIC	PAINT	NONE				
A208D	WOMENS RESTROOM	JPL	SINGLE	2'- 6"	7'- 0"	0'- 1 3/4"	PLASTIC LAMINATE	PAINT	NONE	3B			
A208E	WOMENS RESTROOM	JP	SINGLE	2'- 0"	6'- 0"	0'- 1 3/4"	PHENOLIC	PAINT	NONE				
A208F	WOMENS RESTROOM	JPL	SINGLE	2'- 0"	7'- 0"	0'- 1 3/4"	PLASTIC LAMINATE	PAINT	NONE	3B			
A208G	WOMENS RESTROOM	JP	SINGLE	2'- 0"	6'- 0"	0'- 1 3/4"	PHENOLIC	PAINT	NONE				
A209	LIBRARY	L	PAIR	6'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	NONE	4A			
A211	CLOSET	L	PAIR	4'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	NONE	11A			
A212	ELECTRICAL	JM	SINGLE	3'- 0"	8'- 0"	0'- 1 3/4"	HOLLOW METAL	PAINT	NONE	6C			
A213A	MADRASAH LOBBY	K	SINGLE	3'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	G3	2C			
A213B	MADRASAH LOBBY	S	PAIR	6'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	G3	2A			
A213C	MADRASAH LOBBY	K	SINGLE	3'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	G3	2C			
A216A	RECEPTION	JW	SINGLE	3'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	NONE	4B	1 HR		
A216B	RECEPTION	JW	SINGLE	3'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	NONE	4B			
A217	OFFICE	JW	SINGLE	3'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	NONE	4B	1 HR		
A218	STAFF	L	PAIR	6'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	NONE	4K	1 HR		
A219	MADRASAH AV	L	PAIR	4'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	NONE	11B			
A220	STORAGE	K	SINGLE	3'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	NONE	11C			
A222	CLASS	K	SINGLE	3'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	G3	4C			
A223	CLASS	K	SINGLE	3'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	G3	4C			
A224	CLASS	K	SINGLE	3'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	G3	4C			
A225	CLASS	K	SINGLE	3'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	G3	4C			
A226	CLASS	K	SINGLE	3'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	G3	4C			
A228	CLASS	K	SINGLE	3'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	G3	4C			
A229	CLASS	K	SINGLE	3'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	G3	4C			
A232	STAIR 3	JM	SINGLE	3'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	NONE	5A			
A233	CLASS	K	SINGLE	3'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	G3	4C			
A234	CLASS	K	SINGLE	3'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	G3	4C			
A235	CLASS	K	SINGLE	3'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	G3	4C			
A236	CLASS	K	SINGLE	3'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	G3	4C			
A237	CLASS	K	SINGLE	3'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	G3	4C			
A240A	MENS RESTROOM	JW	SINGLE	3'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	NONE	8A			
A240B	MENS RESTROOM	JPL	SINGLE	2'- 6"	7'- 0"	0'- 1 3/4"	PLASTIC LAMINATE	PAINT	NONE	3B			
A240C	MENS RESTROOM	JP	SINGLE	2'- 0"	6'- 0"	0'- 1 3/4"	PHENOLIC	PAINT	NONE				
A240D	MENS RESTROOM	JPL	SINGLE	2'- 6"	7'- 0"	0'- 1 3/4"	PLASTIC LAMINATE	PAINT	NONE	3B			
A240E	MENS RESTROOM	JP	SINGLE	2'- 0"	6'- 0"	0'- 1 3/4"	PHENOLIC	PAINT	NONE				
A241A	WOMENS RESTROOM	JW	SINGLE	3'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	NONE	8A			
A241B	WOMENS RESTROOM	JPL	SINGLE	2'- 6"	7'- 0"	0'- 1 3/4"	PLASTIC LAMINATE	PAINT	NONE	3B			
A241C	WOMENS RESTROOM	JP	SINGLE	2'- 0"	6'- 0"	0'- 1 3/4"	PHENOLIC	PAINT	NONE				
A241D	WOMENS RESTROOM	JPL	SINGLE	2'- 0"	7'- 0"	0'- 1 3/4"	PLASTIC LAMINATE	PAINT	NONE	3B			
A241E	WOMENS RESTROOM	JP	SINGLE	2'- 0"	6'- 0"	0'- 1 3/4"	PHENOLIC	PAINT	NONE				
A242	BREAK ROOM	JW	SINGLE	3'- 0"	8'- 0"	0'- 1 3/4"	SOLID CORE WOOD	STAIN SN-01	NONE	10B			



- ALL CIRCUIT BREAKERS INDICATED ON THE ONE LINE DIAGRAM ARE THERMAL-MAGNETIC UNLESS NOTED OTHERWISE AS "ELECTRONIC" EXCLUDING THE MAIN WHICH WILL BE ELECTRONIC AND INSULATED CASE.
- POWER CONDUCTORS SHALL BE INDICATED ON ONE LINE DIAGRAM. SUBSTITUTION OF THWN OR THHN IN LIEU OF INDICATED XHHW-2 IS NOT ACCEPTABLE.
- ALL LINE FEEDERS OF INDIVIDUALLY-MOUNTED DISCONNECT SWITCHES AND ENCLOSED CIRCUIT BREAKERS SHALL MATCH LINE SIDE FEEDERS UNLESS LOAD SIDE FEEDER IS SPECIFICALLY INDICATED OTHERWISE.
- GROUNDING FEEDERS SHALL BE INDICATED AS GROUNDING FEEDER CONDUIT BELOW WITH LONG- SWEEP, TRANSITIONAL ELBOWS TO RGS CONDUIT AT WHEN STAFFING UP ABOVE GRADE.
- ALL ELECTRICAL WIRING AND LABEL SHALL BE APPLIED WITH THE AVAILABLE FALL CURRENT AT THE TIME OF INSTALLATION AND CALCULATION. THE LABEL SHALL BE "X" IN SIZE AND SHALL BE BLUE LETTERING ON A CONTRACTING BACKGROUND. THIS LABELING SHALL ALSO BE APPLIED TO ALL ELECTRICAL WHERE FEEDER DESCRIPTION IS NOT SHOWN ON LOAD-SIDE OF ELECTRICAL EQUIPMENT. USE SAME FEEDER AS LARGEST LINE-SIDE FEEDERS, EXCEPT, FOR TRANSFORMER SECONDARY USE SIMILAR FEEDER WITH TWO TIMES AMPLIFY OF PRIMARY.
- WHERE PANEL SCHEDULE DOES NOT INDICATE FULLY-RATED SHORT-CIRCUIT WITHSTAND SERIES-SELECTIVE BREAKERS WITH MINIMUM 22 KAIC BRANCH BREAKERS MAY BE USED FOR THAT PANEL.

ELECTRICAL LOAD ANALYSIS - AUSTIN MASJID					
DESCRIPTION	QTY	RATE		TOTAL	
INTERIOR LIGHTING - OFFICE (NEC 220.12) **	29547	ft²	1.3	VA/ft²	48 kVA
EXTERIOR LIGHTING (ACTUAL)	5	kW	1.25	kVA/kW	6 kVA
GENERAL RECEPTACLE	40.78	kVA	NEC 220.44		25 kVA
MISCELLANEOUS EQUIPMENT	108	kVA	1	Each	108 kVA
WATER HEATING	67	kW	1	kVA/kW	67 kVA
HVAC HEATING *	384	kW	1	kVA/kW	384 kVA
HVAC COOLING *	175	Ton	1.4	kVA/Ton	245 kVA
HVAC MOTORS	69	hp	1.3	kVA/hp	90 kVA
LARGEST MOTOR	10	hp	1.8	kVA/hp	18 kVA
TOTAL POWER					746 kVA
TOTAL CURRENT AT 480V/277 VAC					898 A
* NON-COINCIDENT LOADS					
** USE THE LARGER LOAD					

SUGGESTED SERVICE SIZE 1200A @ 480V/277 VAC

PROJECT NAME

800 N Heatherwilde Boulevard,
Pflugerville, TX 78660

CONSULTANTS



ISSUE FOR PERMIT

REVISIONS

[illegible]

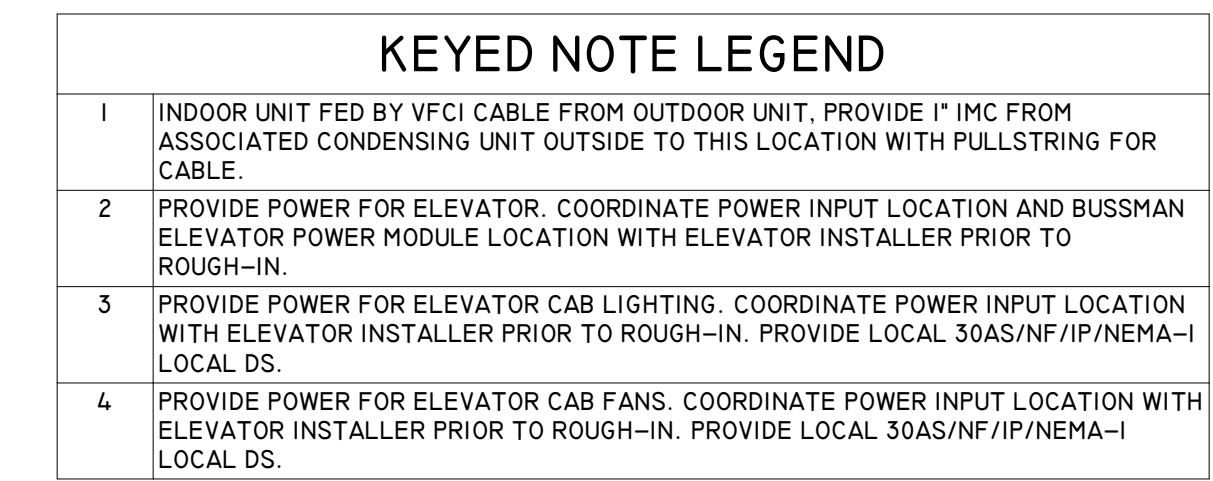
SHEET TITLE

DATE 2026/04/17

PROJECT NUMBER

SHEET NUMBER

E1.02

[illegible]

E2.00

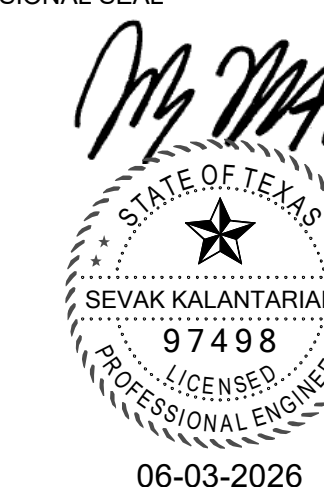
AUSTIN MASJID

800 N Heatherwilde Boulevard,
Pflugerville, TX 78660

CONSULTANTS



PROFESSIONAL SEAL



ISSUED FOR

ISSUE FOR PERMIT

REVISIONS

[illegible]

SHEET TITLE

SHEET TITLE
SECOND FLOOR
POWER

SCALE $1/8" = 1'-0"$

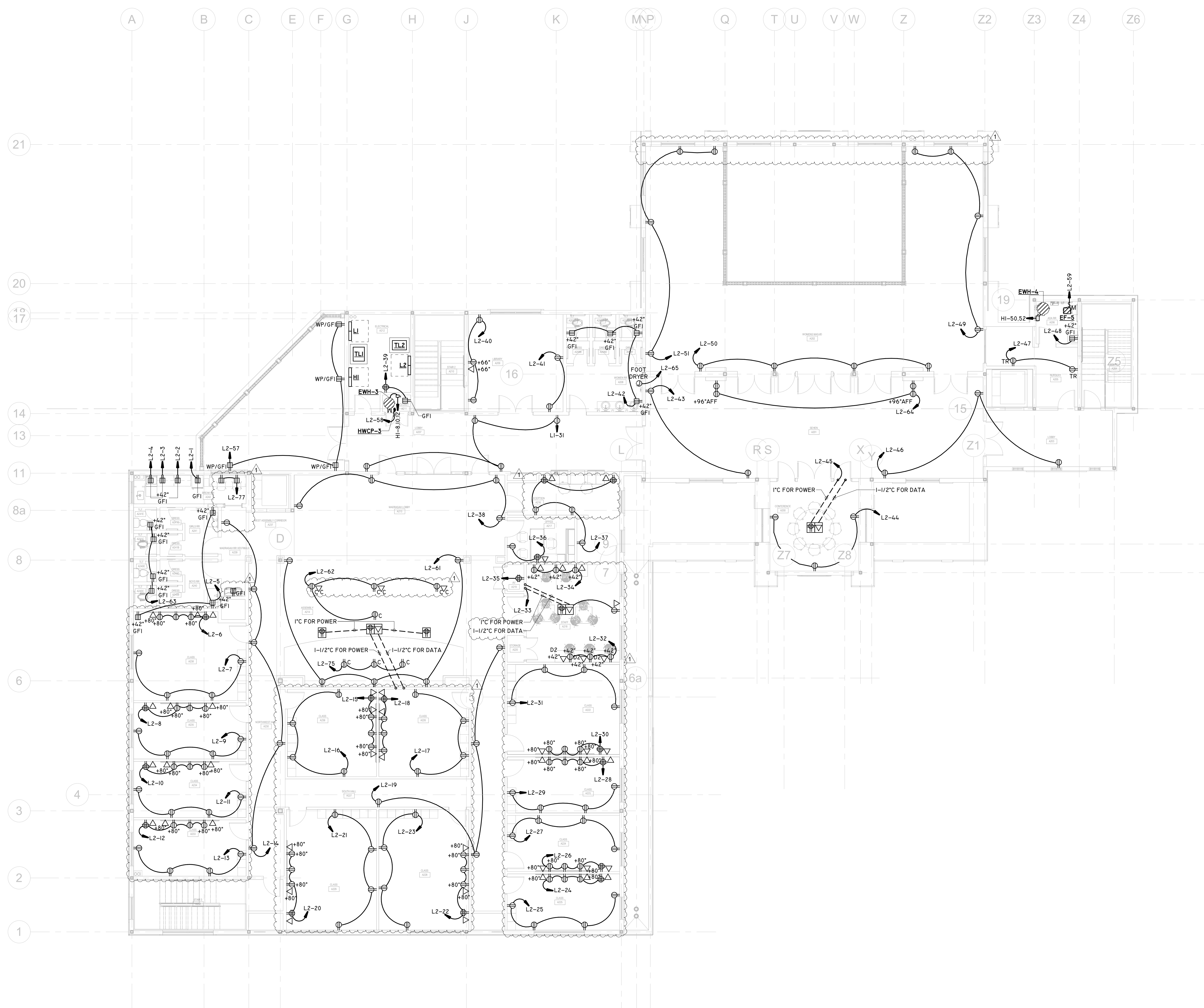
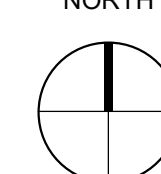
DATE 2026/04/17

PROJECT NUMBER

Project Number

SHEET NUMBER

E2.01

PLAN
NORTH

1 SECOND FLOOR POWER PLAN
E2.01 SCALE : 1/8" = 1'-0"

PROJECT NAME

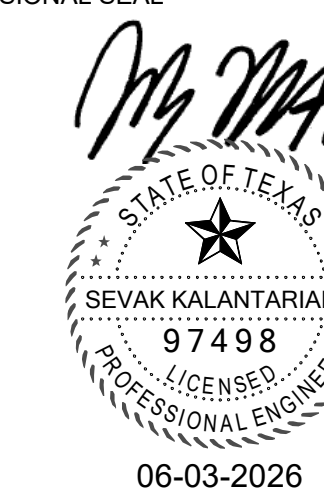
AUSTIN MASJID

800 N Heatherwilde Boulevard,
Pflugerville, TX 78660

CONSULTANTS



PROFESSIONAL SEAL



ISSUED FOR

ISSUE FOR PERMIT

REVISIONS

[illegible]

SHEET TITLE

**FIRST FLOOR -
LIGHTING**

SCALE $1/8" = 1'-0"$

DATE 04/17/2026

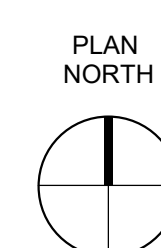
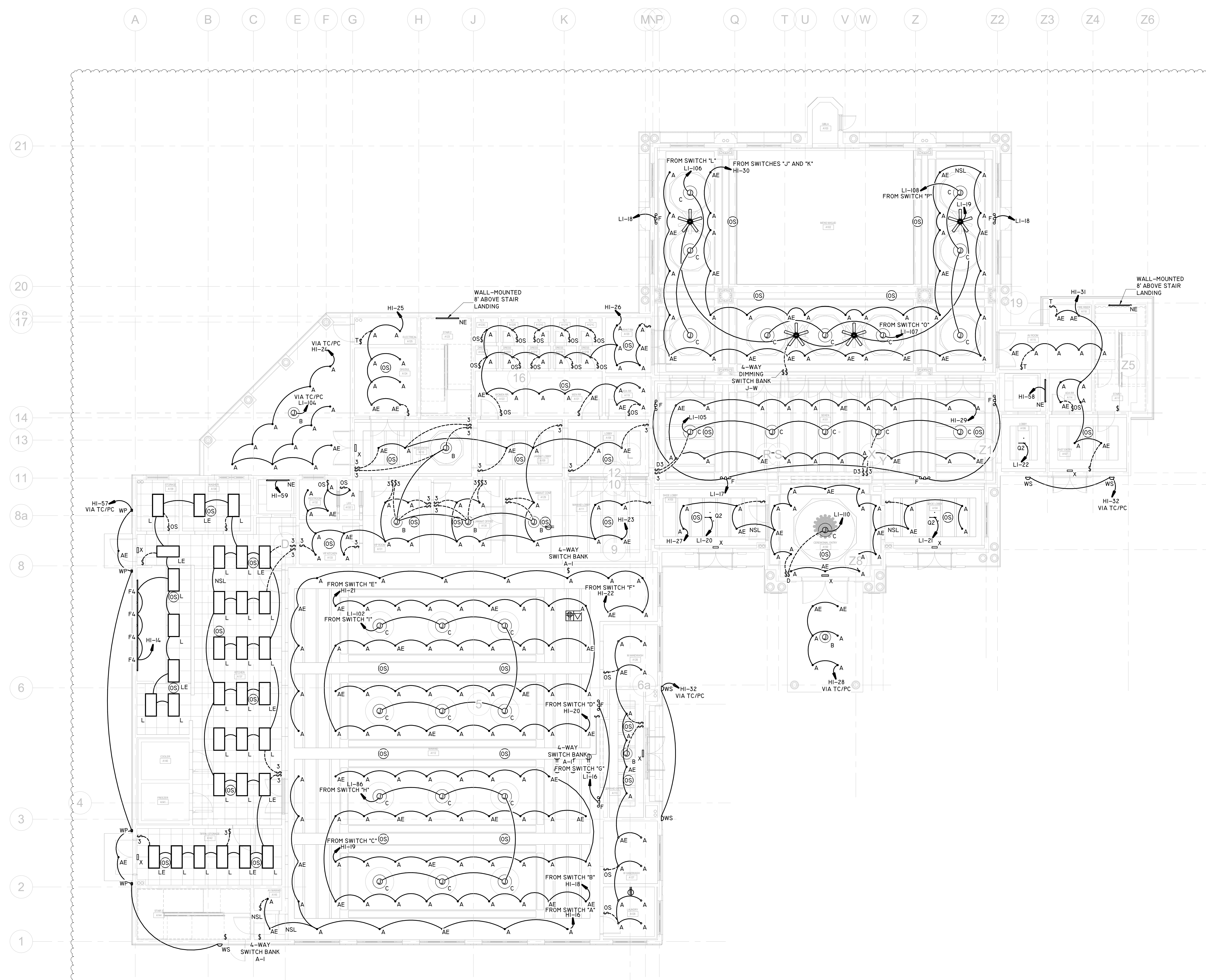
PROJECT NUMBER

SHEET NUMBER

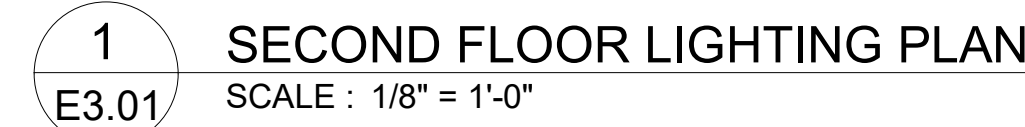
E3.00

GENERAL NOTES:

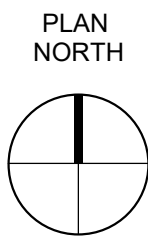
I. COORDINATE WITH ARCHITECTURAL PLANS FOR CHANDELIER
FIXTURE SELECTION INFORMATION.



1 FIRST FLOOR LIGHTING PLAN
E3.00 SCALE : 1/8" = 1'-0"



E3.01



PROJECT NAME

AUSTIN MASJID

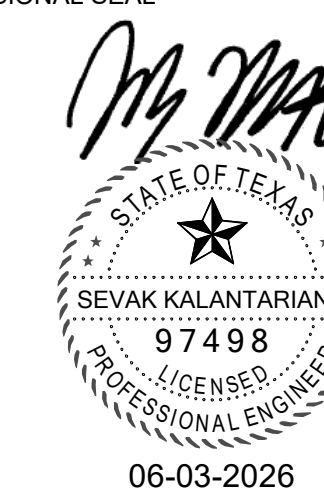
**800 N Heatherwilde Boulevard,
Pflugerville, TX 78660**

CONSULTANTS



INFRASTRUCTURE ASSOCIATES, INC.
6117 RICHMOND AVENUE, SUITE 200
HOUSTON, TEXAS 77057-6267
(713) 622-0120 PH (713) 622-0557 FAX
TBPB FIRM REGISTRATION #F-4506
WWW.IAHOUSTON.COM

PROFESSIONAL SEAL



ISSUED FOR

ISSUE FOR PERMIT

REVISIONS

[illegible]

SHEET TITLE

SITE PHOTOMETRIC

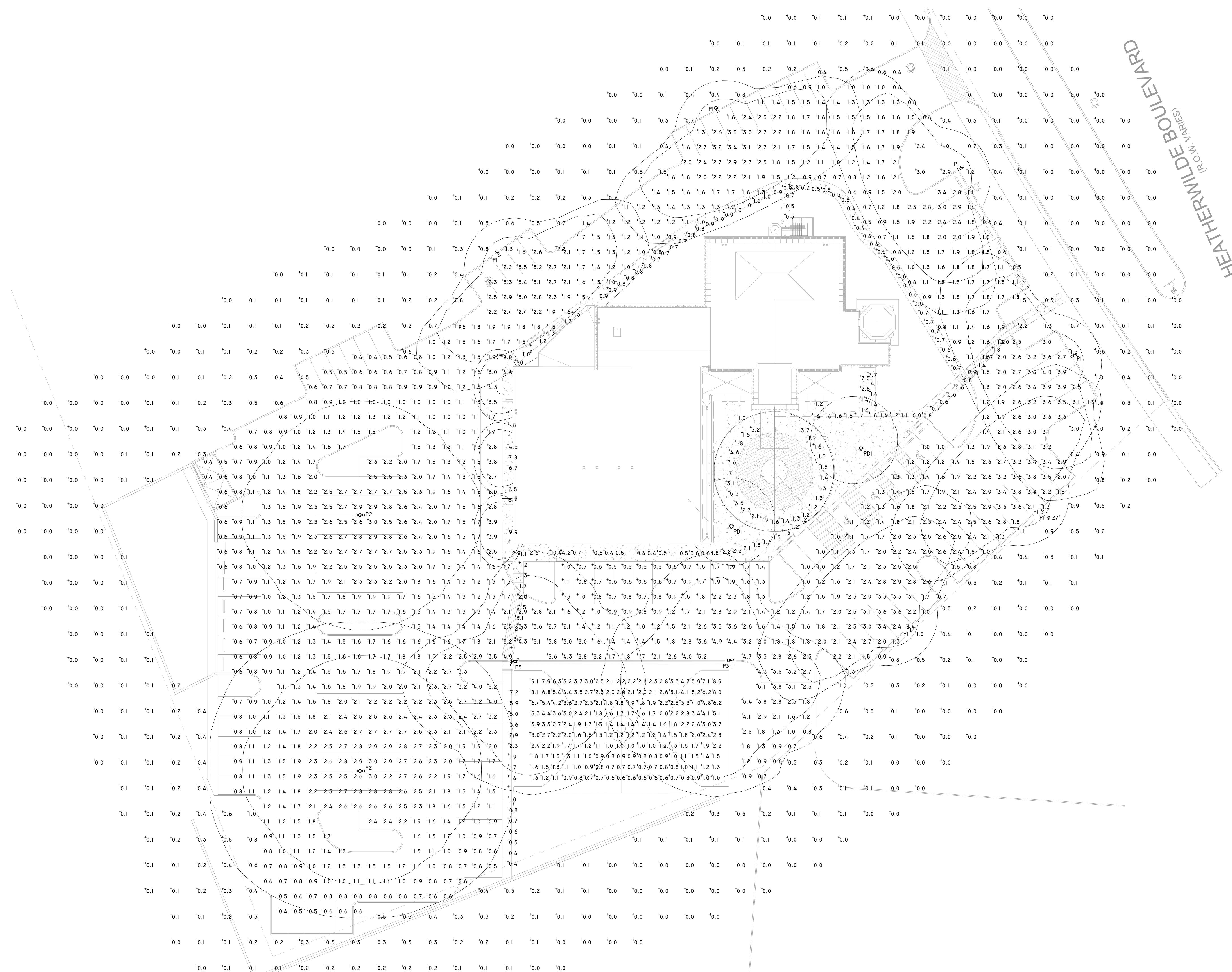
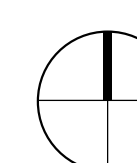
SCALE 1" = 20'-0"

DATE 2026/04/17

PROJECT NUMBER

SHEET NUMBER

E3.02

PLAN
NORT

1 SITE PHOTOMETRIC
E3.02 SCALE : 1" = 20'-0"

